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ESTABLISHED 1843.

EDITED BY

W^M SMITH. C.E.
F.G.S
F.C.S. F.R.G.S
&c

STEAM NAVIGATION SHIP BUILDING AND THE APPLICATION OF CHEMISTRY TO THE INDUSTRIAL ARTS

PUBLISHED MONTHLY.

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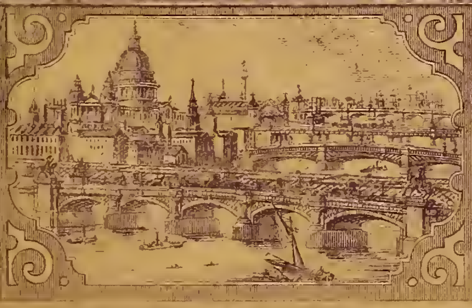

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A Monthly Record of the Progress

OF

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EDITED BY Wm. SMITH, C.E.

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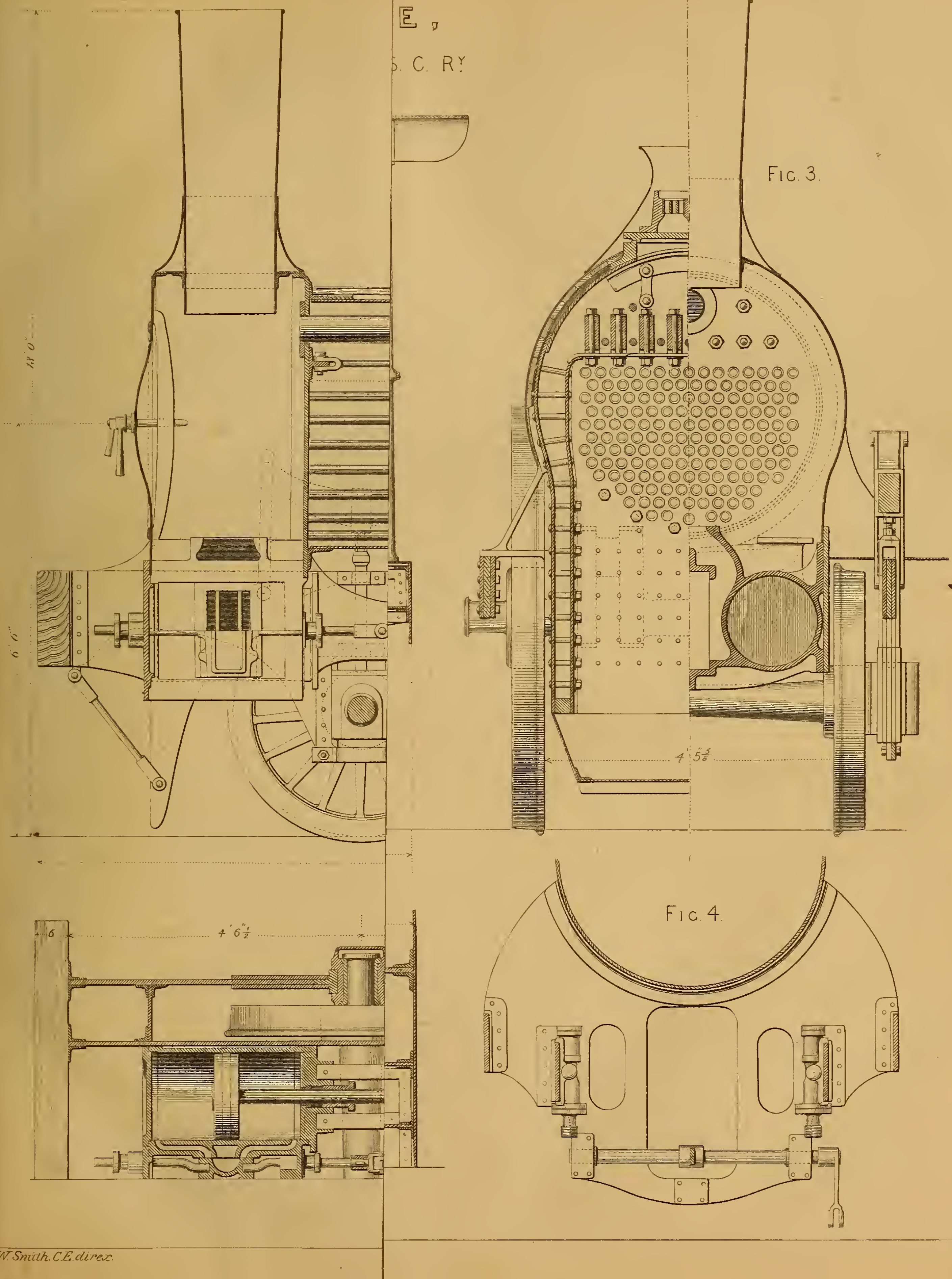

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NEW EXPRESS ENGINE,

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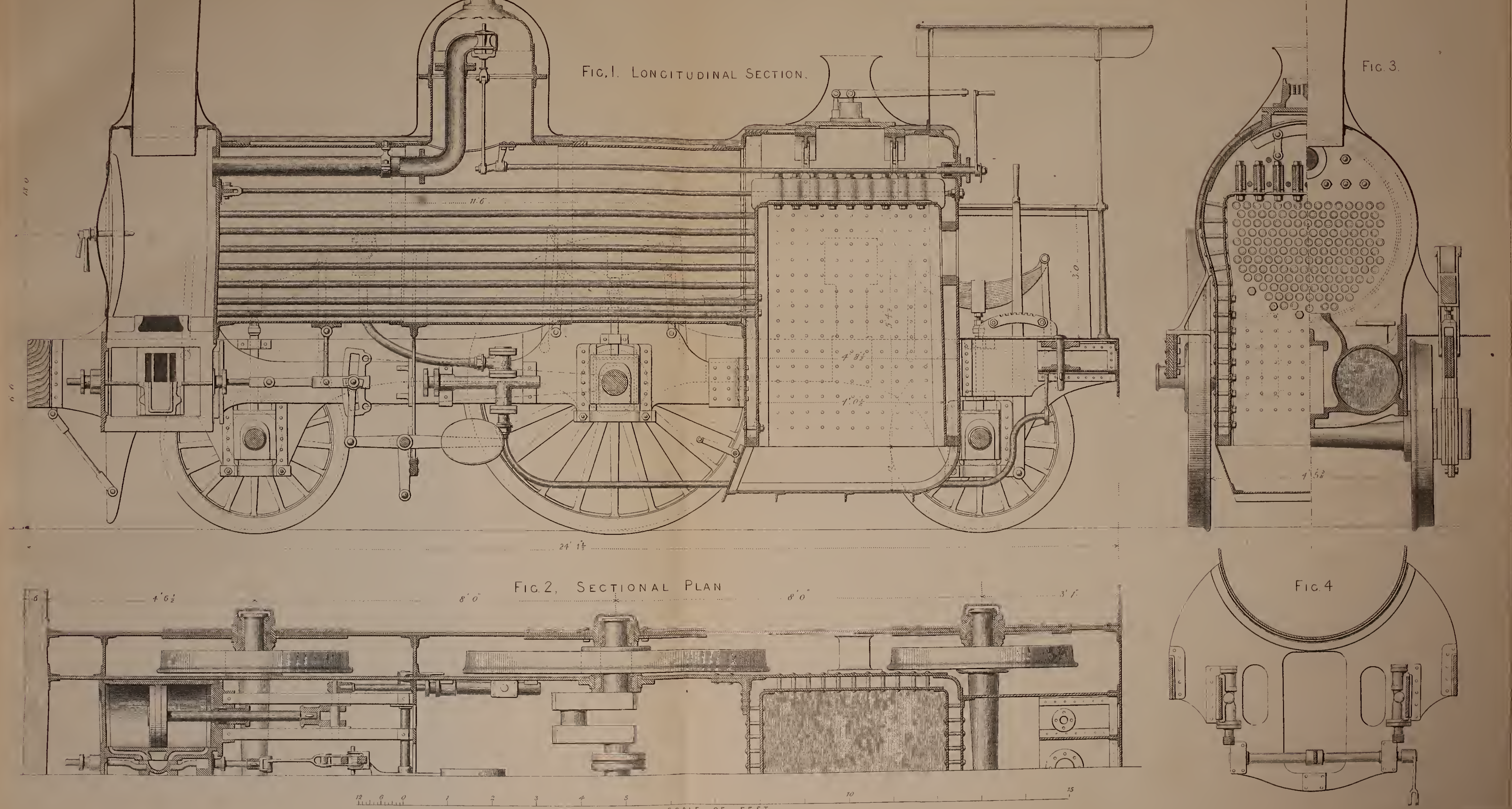


THE ARTIZAN.

No. 1.—Vol. I.—Fourth Series.

1st JANUARY, 1867.

"THE ARTIZAN" ADDRESS 1867.

At the commencement of the twenty-fifth year of the publication of The Artizan, we reiterate our thanks to our numerous friends and patrons for the generous and persevering support they have bestowed on us for well-nigh a quarter of a century.

As a monthly journal, specially devoted to engineering and cognate subjects, The Artizan has been the first in the field, and in that capacity which it assumed from the very outset, it has as yet hardly found a rival in any country in which the English tongue is spoken. Numerous periodicals, most of them weekly, professing to represent the interests of the engineering and industrial community, have followed in our wake, both in this country and in the United States. To none of them we have shown any hostility, but, on the contrary, we have held out to all the hand of good-fellowship. Indeed, just as our scope was not likely to interfere with theirs, we could never construe their aims and endeavours as attempts to encroach on our own preserves. As chronicles of current events in the engineering profession, most of these contemporaries of ours must be considered as ably-conducted channels of information on the "topics of the day." Whilst in this country their task is chiefly confined to this object, our Transatlantic *confrères* combine with it the part of advertising mediums which they sustain with much skill, though, in many cases, with some want of discretion. On the other hand, the aim and object of The Artizan has never been to form a mere record of current facts and events, but rather a mirror of the progress through which the industrial professions have gone for several decades past, and which they are steadily undergoing on the present day. Thus, the materials supplied by us have always been of a more solid and substantial kind than those to be obtained from the purveyors of professional news. To other hands we abandoned the task of keeping the engineering public *au courant* of all new ideas, new inventions, new schemes, irrespective of their intrinsic merit and value, in fact of all matters and events of an importance merely ephemeral or transitory. We, on the contrary, prefer to give to our journal the distinctive feature of continuity and permanence combined, by scanning, screening, and sifting the raw materials, and selecting the kind of information we supply in such a manner that not only the monthly parts of our journal may meet the requirements of the day, but its volumes, when collected, may form a work of reference, useful and valuable in after years.

On these principles The Artizan has been conducted for nearly a quarter of a century; up to this day they have enjoyed the unqualified approval and support of the mechanical public, and, therefore, we mean to adhere to them in future as in the past. While preserving, however, the character of uniformity and homogeneity to our journal, so essential to its literary value, we have introduced from time to time, and shall continue to introduce in future, such improvements as will secure to each individual part that actuality which is generally found wanting even in the most distinguished non-serial works, after some lapse of time.

During the year just ended the duties devolving upon this journal as an organ and mouthpiece of industry, as an advocate of its interests and, at the same time, a record of its progress, have been most multifarious and to some extent onerous. We have endeavoured, to the best of our ability, to discharge these duties to the satisfaction of our supporters. Should we have failed in some respects to reach the standard assigned to us by some, we feel still certain of not having disappointed any reasonable expectations; and strengthened by this conviction, we trust we may both rely on the support and concurrence of our numerous friends of many years' standing, and enlist the good will and co-operation of our new supporters. Reasonable demands on the part of our readers, if duly communicated to us, we shall always meet with a willing ear and endeavour to satisfy, insofar as the fulfilment of the wishes of one section should cause no prejudice to the regard to which the majority is justly entitled.

No less than in the history of the world at large, the past year will form a distinguished epoch and landmark in the history of the engineering profession and the industrial arts generally. Politics do not belong to the province of The Artizan; and in laying now, as was our wont in former years, a short restrospect of the events of last year before our readers, we shall touch only on such matters as have a direct bearing on industrial sciences and arts, and abstain from alluding to subjects foreign to these, save where an indissoluble connection exists between both.

To us, the leading event of 1866 is the successful result of the enterprise first started in 1857, for joining the countries of the eastern and western hemispheres by means of an electric cable. Well may the British nation exult in this glorious and lasting triumph of its genius, energy, and perseverance, but of the credit due to the community at large, one section at all events, viz., the engineering profession, comes in for a lion's share. To the men of an age, which will soon be called by-gone, belongs the practical application of the science of calorics to locomotion both by land and water; it is the present generation that glories in the merit of having first utilised the sciences of electricity and magnetism, for the purpose of conveying information to distances bounded only by the extent of our globe, with a rapidity far exceeding the ocular speed of lightning. Most adults of the present day fully remember the time, when telegraphy was unknown all but by name. During the last twenty years, nets of electric wires have been spread over all civilised countries of Europe and America. From telegraphs passing over rivers and mountains, we proceeded to those resting on the bottom of the sea. The first submarine telegraph cable, not exceeding thirty miles in length, was laid between Dover and Calais in 1852, and numerous lines connecting England with Belgium, Holland and Germany, France with Algeria, Italy with Turkey and Egypt, followed in the course of twelve years. But most of these lines were of a comparatively limited extent, not one of them exceeding 500 miles' length from land to land. An enterprise of far more gigantic proportions remained to be carried out; the laying of a transatlantic cable, to join two continents distant almost 3,000 miles from each other at their closest proximity, was first attempted, by the joint efforts of British and American engineers, as far back as 1857. The experiment failed, and the enterprise lay dormant for several years. An undertaking of gigantic proportions required, as a means of transport, an agent of locomotion of gigantic dimensions. And here it may not be out of place to claim, in our own favour, some little share of the honour due to those who proposed the scheme, and carried it to a successful end:—

1st. The editor of this journal was the first person who proposed, as early as 1846, the formation of telegraph cables, that might be manufactured of unlimited length, by aggregating a number of insulated copper wires, to serve as a core, whilst external iron wires or strands would constitute the protecting covering. This suggestion he made to Mr. Brett (thereafter the *concessionnaire* of the Calais and Dover telegraph line) whom he satisfied of the impossibility of constructing Mr. B.'s "inter-oceanic"

lines of communication by any other method than the one proposed. With a view to demonstrate the practicability of the proposition, specimens of telegraph *cables* of various lengths were made at the cost of the suggestor, and presented to Mr. Brett, in whose opinion invaluable personal advantages were likely to accrue from the scheme both to himself and to the proposer. This expectation, however, has been but partially realised.

2nd. At a time when the *Great Eastern*, alias *Leviathan* was still on the stocks and in progress of construction, we first suggested to have the shell of the monster vessel appropriated for the purpose of receiving and laying the then proposed Atlantic cable. In the issue of October 1, 1856, having expressed our opinion that a vessel of extraordinary size should be employed to carry the whole cable and ensure the success of the enterprise, we proceeded to say :—

To find a vessel capable of holding the whole of the Atlantic cable, is a matter of the first importance for the progress and success of the undertaking.

Now, our suggestisn is, that the first employment of the great ship, after she has been launched, should be to take ou board the entire cable, and thus aid the projectors of another great undertaking of world-wide importance, in carrying out their enterprise.

The great ship is in every way suited for this undertaking, and it would be an immediate and profitable employment, in which her sea-going capabilities and the working of her machinery might be practically tested, before incurring the great expense of fitting up her iuterual arraugements for the convenience and comfort necessary for the purpose of passenger accommodation. Here, also, would be a source of obtaining the means of finishing the vessel according to the original desigu, in a suitable manner, resulting from the experience gained whilst so employed, and that, too, without calliug for the necessary capital from the shareholders.

Our suggestion was neglected at first. The *Leviathan* was entirely fitted as a passenger vessel, and as such she proved a failure, financially speaking; but at last the idea was taken up and endorsed by the projectors of the enterprise of '65. A new cable having been completed, it was coiled on board the *Great Eastern*, who set out on her voyage in June 1865. This attempt to lay the cable also failed, chiefly owing to defects in the paying-out arrangements and want of proper grappling tools; but the courage and tenacity inherent to the Anglo-Saxon race could not be daunted by the disaster. In July 1866 the same vessel weighed her anchor ouce more off Valentia, with a new cable on board, aud no accident intervening, the latter was successfully laid, and its opposite extremity landed at Heart's Content.

The intelligence of this favourable result was speedily followed by the news of the raising of the cable of 1865, and the subsequent completion of this second line. These two cables will form a legacy the present generation will bequeath to the "epigones" as a lasting monument—

Quod non imber edax, non Aquilo impotens
Possit diruere—

in the words of the Roman poet. We have desiguated their successful laying as a triumph of British genius and engineering and commercial enterprise, but whilst the names of Canning, Thompson, Gooch, and Anderson, will be graven henceforth on the tablets of science, the annals of telegraphy will record, with no less credit, the uame of Cyrus Field, the indefatigable American projector, to whose energy and unceasing activity the success of the undertaking is due to no inconsiderable degree.

Amongst the engineering events of 1866, we have allotted the first and foremost place to, and dwelt to some extent upon, the transatlantic cable, chiefly owing to the perpetuity and monumentality which are its leading features. Besides, it forms the most prominent fact worth recording, within the province of the sciences of peace. Indeed, *civil* engineering has acted altogether the part of a Cinderella during 1866, as compared to *military* and *naval* engineering, both of which have, during that period, obtruded themselves almost forcibly on the attention of the scientific and general public. Many facts, otherwise fully deserving of notice, have thus been thrown into a background, under the haze of powder smoke and by the crashing of shot and shell. Hence, we need not apologise for doing but scanty justice to their importance, by confining ourselves to a mere enumeration of them.

An average increase in the mileage of the railways of the United Kingdom, and chiefly within the Metropolis, has taken place during the last twelve months. Of continental railroads we may mention the line over the Mont Cenis, which is progressing favourably; the Heidelberg-Mosbach-Würzburg line, just comploted, facilitating the communication between Eastern France, South Western and Central Germany; the completion of the first section of the Warsaw and Moscow line, and some slight progress in the construction of the Italian railway belt and the Iberian railway net. In the United States, most of the railroads that had been destroyed or appropriated for military use during the civil war, have been relaid and resumed their original destination.

In the province of telegraphic engineering, the laying of an additional cable by Mr. Reuter, between the south-east coast of England and the north-west coast of Germany, dwindles down to almost diminutive importance by the side of the transatlantic connection. Towards the completion of the telegraph net, little remains to be done in this country; on the Continent some further slight progress has been perceptible.

The alarming increase in the number of boiler explosions, railway accidents, and mining disasters, noticeable in England during 1866, invites greater solicitude on the part of the engineering public, in providing proper means of safety; but it is more particularly requisite and urgent that the baneful system of *laisser aller*, on the part of the executive, should at last be superseded by that stringency and efficacy of Government control and supervision to which the community at large is entitled. The series of these sinisters, culminating in the Barnsley and Hanley colliery explosions, may be set down as one of the darkest blots on our present civilisation, and the culpable negligence with which human life is continually jeopardised and sacrificed in this country, contrasts most unfavourahly with the care and solicitude bestowed on the interests of the public by continental Governments.

In the first half of 1866, a commercial and industrial crisis, coming on with a sudden crash and collapse, destroyed millions of property, threw out of employment many thousands of hands, and annihilated the welfare and comforts of a large section of the community. Its ravages have been felt most disastrously amongst the engineering and shipbuilding trades. The business of the latter, chiefly in the Metropolis, having already been very slack for some years past, had by the crisis of last May, a blow inflicted upon it from which it has not yet recovered. At this moment, the energy of thousands of arms is lying fallow, and numerous palliatives are being resorted to, to alleviate the destitutiou of these once prosperous workers. Our excellent free-trade system, sophisticated by workmen's strikes and masters' combinations, threatens to divert the stream of internal and international industry from the shores of England partly to those of North Britain, chiefly to foreign couutries, fully prepared to undersell and thus eclipse us. To this topic, a subject of most vital importance to the interests of our constituents, we purpose to devote special attention hereafter.

The crisis, to which we have just alluded, originated in the preludes of the war then preparing in Central Europe, which, towards the end of June, actually broke out between Prussia and Italy on one side, Austria and the middle states of Germany on the other. The events of this strife, insofar as their political results are concerned, do not belong to our province; their scientific and technical results certainly do. Some of the most important problems of military and marine engineering have been definitively solved, others brought nearer their solution by the seven days' campaign in Bohemia and the naval struggle in the Adriatic. To the former class belongs the case of breech-loader *v.* muzzle-loader. It has been finally decided at Nachod, Skalitz, and Sadowa, that the muzzle-loader cannot hold its own against a weapon by which at least four times as many shots may be fired in the same space of time, *ceteris paribus*. Irrespective of the Northerner's superiority over the Southerner, Dreyse's *Zündnadelgewehr* alone would have decided the fate of the campaign, when opposed to the Austrian Brown Bess. At Langensalza the Prussian was fully matched by the Hanoverian, armed with the identical needle gun and furnished with the identical ammunition; whilst on the Maine the Confederate army, supplied with muzzle-loaders, fared no better than the Austrian in Bohemia. On the other hand, the result of the day of Custoza, where both Austrians and Italians used a weapon equally defec-

tive, proved nothing but the superiority of the man of the Teutonic over him of the Latin race.

In substance, the question has thus been solved, but in its details it has not yet been matured. Manifold are the rifles that are now being brought forward with a view to satisfy the breech-loading mania *en vogue* on the present day. In Prussia, henceforth the classical country of the breech-loader, Herr von Dreyse's rifle is still adhered to, and its egregious defects are reported to have been suppressed by the distinguished inventor. In England, the adoption of the Snider system for the conversion of the Enfield rifle was decided upon by the authorities of Pall Mall, which have dealt with the inventor in a manner open to much animadversion; the substitution of a *boná fide* breech-loader is to follow. In France, the Chassepot rifle, adopted by the War Office for the armament of the proposed additional million of soldiers, is stated to be an improvement on the needle gun. A similar movement is going on in most other countries of Europe. Throughout these changes, one consideration which, however, happens to be the most important, is entirely lost sight of; viz., that, however excellent the weapon, its value is dependent upon and enhanced by the skill of him who uses it. In future, as in the past, it is not the number of men, but their qualities that will decide the issue of battles. The intelligent soldier, though his weapon be defective, will yet gain the better of the brute armed with a rifle of the most perfect construction. A well-educated nation will, in future, still hold its own against a host of well-drilled barbarians.

With regard to naval warfare, the sea-fight of Lissa has verified an opinion which we set forth in 1862, when the affair of Hampton Roads had thrown the whole marine public of Europe into alarm, and our noble old wooden walls were cut down to make room for ironsides. We asserted then, that a well-manned timber ship might still bid defiance to a badly-manned iron-clad, and such was the case at Lissa. Persano, having at his disposal 36 ships, 8 of them partially, 4 entirely iron-clad, with 614 guns, and 12,130 horse-power, was met by Tegethoff, whose aggregate force consisted of but 27 ships, (6 of them mere apologies for men-of-war), with 531 guns, and 10,610 horse-power. The issue of the combat was a thorough discomfiture of the Italians, who, though remaining masters of the *champ de bataille*, lost the *Re d'Italia* and the *Palestro*, two of their best American-built iron-clads, and had their proud Monitor, *l'Affondatore*, the sinker, so badly used that she actually *sunk*, a few days later, in the harbour of Ancona, in consequence of the injuries she had received. Not one of the Austrian ships, wooden or iron, was lost; even the wretched old wooden *Kaiser*, having received many shot-wounds while ramming the Italian Monitor, soon recovered. The affair of Lissa clearly proves that the result of a naval struggle will depend far more on the qualities of leaders and men than on the construction of the ships. An ill-manœuvred iron-clad will still be at a disadvantage when opposed to a well-manœuvred timber ship, especially one furnished with a ram, and armed with heavy guns.

In this country the experimental trials of ordnance on targets are not yet terminated; they bid fair to continue indefinitely, unless the practical results of these researches should be called in requisition by actual test in war.

Having sketched, in a few broad outlines, the most prominent engineering events of the past year, we regret to be prevented, by want of space from going more fully into them. However, as most of the facts alluded to have been treated more explicitly in our last volume, this retrospect may be deemed sufficient as a *résumé* and recapitulation of facts connected with the industrial arts in 1866.

In the current year we shall endeavour to enhance the value of our publication by further improvements in its various parts. The forthcoming Universal Exhibition of Paris is, in our opinion, not likely to prove such a success as its predecessors of 1851 and 1855; yet it will form a most remarkable, perhaps unique, aggregation of objects of science, art, and industry, and an account of its most prominent features will be welcomed both by those who visit it and by those who cannot judge of it *de visu*. Arrangements have already been made with a view to meet the wishes of our readers in this respect, and, by a direct representation on the spot, THE ARTIZAN will be able to give full and explicit reports, and reliable information, on all subjects of interest connected with the forthcoming world's fair. In all other respects we hope our endeavours to satisfy the reasonable desires of the engineering public will breed mutual confidence and goodwill between the ARTIZAN and its supporters.

ON VAST SINKINGS OF LAND ON THE NORTHERLY AND WESTERLY COASTS OF FRANCE, WITHIN THE HISTORICAL PERIOD.

By R. A. PEACOCK, Jersey.

(*Continued from ser.* iii., *vol.* 4, *page* 270.)

CHAPTER VII.

In attempting to elicit truth from the many interesting facts collected, the author has been obliged to pursue it into each of the seven following sciences:—Antiquarian, Civil Engineering, Conchological, Geographical, Geological, Greek and Latin, Philological. And where his own learning was insufficient, as in conchology, he thankfully acknowledges willing help received from J. Gwyn Jeffreys, Esq., F.R.S., F.G.S., and from George Metivier, Esq., of Guernsey, and Professor Williams, of Lampeter College, in philology. And this is all the answer he thinks it necessary to give to remarks sometimes made—"It must have taken you a deal of time," and "It is all copied from books," and the like. Scientific truths are always discovered and established first, and then in due time (often in a short time) their results in promoting good or remedying evil follow, though for the moment we may be unable to see how the advantages are to be secured.

DR. FLEMING'S THEORY NOT APPLICABLE TO THE CHANGES ON THE FRENCH COASTS.

124. In the Edinburgh "Philosophical Transactions"* is a very interesting paper entitled "On a submarine forest in the Frith of Tay, with observations on the formation of submarine forests in general." A bed of peat, he says, occurs on the south side of the Frith of Tay, ten miles in length. It is in detached portions to the extent of nearly three miles on the west side of Flisk beach, and upwards of seven miles on the east side. Upon its surface may be perceived the stumps of trees, with roots attached, and evidently occupying the positions in which they formerly grew; many of the trunks and roots occur from 8ft. to 10ft. below high water mark. He says Mr. Watt, of Skail, thinks it may have come to its present position by the removal of a bank of earth 18ft. deep, washed gradually away. To this theory Dr. Fleming well objects that it is not likely that "a continuous bed of peat of nearly an acre in extent would be spared from destruction and suffered to settle peacefully in the Bay of Skail, so as to be covered at flood tide with 15ft. of water."

He quotes the Rev. Mr. Borlase, F.R.S., on a submarine forest observed in 1757 at Mount's Bay, Cornwall, of which more in Article 133. And he says that Dr. Correa de Silva ascribes the depressed position of the submarine forest of Lincolnshire to the force of subsidence, aided by the sudden action of earthquakes.—"Phil. Trans.", R.S., 1799. He says Professor Playfair conceives it to be a part of that geological system of alternate depression and elevation of the surface, which probably extends to the whole mineral kingdom. He is tempted to think that the forest which once covered Lincolnshire was immersed under the sea by the subsidence of the land to a great depth at a period considerably remote. That it has emerged from this great depth till a part of it has become dry land, but that it is now sinking again, if the tradition of the country deserves any credit; and that the part of it in the sea is deeper under water than it was a few years ago.

Dr. Fleming's paper was read June 17, 1822, and at that time he thought

* Vol. ix., p. 419, &c., for 1823, by John Fleming, D.D., F.R.S.E.

the subject was imperfectly understood, and offered the following solution:—

He supposes a lake near the sea shore, with its outlet a few feet above the rise of tide, and that by mud being carried into it by rivulets, and by the growth of aquatic plants, the lake becomes a marsh of sufficient density to support trees. The force of ordinary subsidence, aided by occasional earthquakes, may render the whole tolerably compact, yet the quantity of water present will prevent anything like the ordinary condensation of ordinary alluvial land or soil. Suppose such a marsh to have its outlet lowered, or rather its seaward barrier removed, the extremities of the strata would then be exposed to the sea to a depth equal to the fall of tide, and the water would then ooze out. All above low water mark would collapse, and the marsh would sink below the level of the sea. But the drainage, he thinks, would not be confined to beds above the low water line; those occupying a considerably lower position would be influenced. He says, "for the water in such would be squeezed out, in consequence of the pressure of all the matter above low water exerted during every ebb, in the expulsion of the water at the lowest level, thus permitting the subsidence of the strata to take place to the lowest beds of the morass." He thinks this would account for the depression of the marsh many feet below its original level. And the same explanation "seems equally applicable to the forests of Mount's Bay, Lincolnshire, and Orkney."

125. Now, *first*, Dr. Fleming's objection to Mr. Watts' theory applies still more forcibly to his own theory. How could storms and Atlantic waves spare from destruction, and suffer to settle peacefully, the extensive peat beds containing whole forests of trees, on the west of Guernsey and Jersey, to say nothing of the Bay of S. Michel? The south-westerly waves and storms of the Atlantic are more forcible than those of the Frith of Tay, and the tides are respectively 32ft., 42ft., and 54ft. as compared with 15ft.

Second, can the cautious reader really believe that the very extensive submarine forests about the Channel Islands and neighbouring coasts of France, have once been living forests *afloat on lakes?* Is not this far more improbable than to suppose that the land has quietly sunk down, there being so many well ascertained instances of land both rising and sinking?

Third, why will he not be content with the "ordinary subsidence," which he admits and which is sufficient to account for everything; for as he has admitted it, he cannot arbitrarily limit its amount?

But, *fourth*, even if we lay aside these three objections which would be difficult to answer,—we should have, even if we made him a present of all he contends for,—the extraordinary spectacle of a forest rising and sinking alternately (to the amount of 54ft. in the Bay of Mont S. Michel) every time the tide flowed and ebbed! And the more so, because if sea water was substituted for fresh water, the buoyant power would be increased, as is well known, by 2lbs. per cubic foot. But the alternate risings and sinkings with the tides, of submarine forests on the coast of France, do not now and never did take place; and they are not true, with respect to the French coasts now under consideration.

126. Elevations and depressions of strata are the *rule* and *not the exception*, and have been so in all ages all over the world. And it is surprising that any theory whatever, provided it be other than rising or sinking of land is suggested; and more than that, suggested eagerly and adopted readily; often in the face of possibility. Any and every wild and improbable supposition has at one time or another been resorted to, but a great fact in nature; namely the very frequent depressions of strata has equally often been shunned. How much ingenuity and thought has been brought to bear (must we not say wasted?) rather than accept the well proved theory of sinking!

CHAPTER VIII.

Diodorus Siculus.

127. There is passage in the work of the historian Diodorus, which appears to have an important bearing on the question now under consideration. But it has been denied by some that the passage in question refers to the Channel Islands at all. It is now proposed to lay down as fairly as may be, both the reasons for believing that the passage really does refer to the northern Channel Islands, and the reasons which have been alleged against that belief. And, first, it is important to consider who Diodorus was, what degree of knowledge he probably had on the subject; and, thirdly, the probable amount of fidelity in recording that knowledge. His credulity as to the heathen gods and goddesses is only what might have been expected from a heathen, and does not affect the question, of his general trustworthiness. He gives some notices of Gaul and Britain most elaborate and detailed with respect to the former. Which circumstance makes his statements especially interesting and important on the present occasion. For there can be no reasonable doubt that he was in Gaul for a considerable time, carefully observing and recording his observations of men and things: and he doubtless saw the Channel Islands.

128. It is said of him in Dr. Lempriere's "*Classical Dictionary*,"* that he was "an historian, surnamed *Siculus*, because he was born at Argyra, in Sicily. He wrote an history of Egypt, Persia, Syria, Media, Greece, Rome, and Carthage, which was divided into forty books, of which only fifteen are extant, with some fragments. This valuable composition was the work of an accurate enquirer, and it is said that he visited all the places of which he has made mention in his history. It was the labour of thirty years, though the greater part may be considered as nothing more than a judicious compilation from Berosus, Timæus, Theopompus, Callisthenes, and others. The author, however, is too credulous in some of his narrations, and often wanders far from the truth. His style is neither elegant nor too laboured; but it contains great simplicity and unaffected correctness. He often dwells too long upon fabulous reports and trifling incidents, while events of the greatest importance to history are treated with brevity, and sometimes passed over in silence. His manner of reckoning by the Olympiads, and the Roman consuls, will be found very erroneous. The historian flourished about 44 years B.C. He spent much time at Rome to procure information, and authenticate his historical narrations. The best edition of his works is that of Wesseling, 2 vols. fol., Amst. 1746."

In 1823, perhaps, Wesseling's was the best edition.

129. Degory Wheare, the earliest reader of history on the Camden foundation, at the University of Oxford, gives a careful statement as to Diodorus, which will be quoted from.† Wheare says, p. 66:—"Diodorus was a celebrated writer and so expert in antiquities, that Greece can scarcely show another that is his equal; which judgment may be confirmed by the elogie [eulogy?] which a learned divine of our country, a bishop, and well versed in this [history] and all other sorts of learning, is pleased to bestow upon this author. Diodorus Siculus (saith he) is an excellent author, who with great fidelity, immense labour, and a rare both diligence and ingenuity, has collected an historical library (as Justin Martyr calls it) in which he has represented his own and the studies of other men, being the great reporter of human actions; but as Diodorus himself styles it a *common treasury* of things, and a harmless or safe mistress or teacher of what is useful and good. Our reverend bishop might well call it an *immense labour*, for he spent thirty years (as he himself confesseth) in writing this history, travelling in the meantime over several countries to inform himself, running through many dangers as usually happens." Wheare also says, at p 48, that "Lodovicus Vivis, who admires how Pliny could say that Diodorus was the first of the Grecians who left off trifling, when, saith he, there is nothing more idle [than Diodorus's first five books.] But we [Wheare] reply, that learned censor did not well consider that Diodorus himself owns that the history of those times was mixed with many fables, and delivered very variously by the ancients, but he was content to relate what seemed most agreeable to the truth, and yet at last

* 12th edition, 1823.

† On the "Method of Reading Histories," by Degory Wheare, translated into English by Edmund Bohun, Esq., and published, London, 1694.

he did not desire that they should be taken for solid truths, but that he thought it was better to have the best knowledge we could of those ancient times, than to be altogether ignorant of them."

130. Diodorus himself mentions that he was a cotemporary of Cæsar, for in Book VI., chap. ix,, he says, speaking of she Rhine, "which in *our* days C. Cæsar joined (the two banks) with bridges in a wonderful manner, and conveyed across his infantry," as Cæsar himself also relates that he did.* He survived Cæsar and lived in the reign of Augustus.

130. *The subject-matter of Diodorus's History.*—In his first four and part of his fifth book he relates many "traditions" and "fables," as well as many interesting particulars of various personages, peoples, and places which do not concern the present subject. He then gives a highly condensed description of Gaul and the Gauls,† of which the following account and summary will probably satisfy the reader that Diodorus was present amongst the Gauls, observed them closely, and, doubtless, saw the Channel Islands, and the "peculiar" circumstance which he relates afterwards. The translation of his narrative, even when somewhat condensed, occupies five and a half closely written quarto pages, and is too long to be reprinted entire. The recital of a few prominent facts appears to carry with it internal evidencee both of his truthfulness, and of his having been for a considerable time present among the Gauls. One trifling inaccuracy, not at all affecting the present questiou, is the more remarkable from standing alone, namely, when he says the Danube flows into the ocean. His statement, which has caused so much disbelief, namely, that the winds blow so strong that they propel stones with sufficient force to knock armed men off their horses,—has lately received a remarkable corroboration, the scene of which was the mountain Matterhorn, also among the Alps.‡ Edward Whymper, Esq., in describing his ascent of the Aiguille Vert, says:—"The Matterhorn rains down showers, nay torrents and avalanches, of stones both day and night."

Abstract of Diodorus's Description of the Gauls.

He describes Gaul, the people, and their number; the many rivers, and whence and whither they flow. Cæsar passed the Rhine "in our days" in a wonderful manner and conquered the Gauls beyond it. He omits for brevity, the names of many navigable rivers. In summer the winds blow from the north and west with such force that they form considerable heaps of stones, as large as the hand can hold, and they knock armed men off their horses. Neither wine nor oil is produced; beer, and honey and water are drank. They get drunk with wine, fall asleep, or go frantic. It is served out from ships or carriages. Coin is scarce. He describes, in detail, how and where they get gold, melt it, and both sexes use it for ornament, namely, as bracelets on their wrists and arms, "torques" of solid gold on their necks, on their fingers as rings, and as gold on their breasts. They all offer much gold to the gods, neither dare any one steal it from the temples, though all are greedy. He describes their persons, their stature, the colour of their hair, and how they dye and wear it, and increase its apparent abundance. Some shave the beard, some grow it sparingly; the nobles shave their cheeks, but let their beards grow. Food lodges in their beards, and drink descends through them as through a canal. They sup sitting on skins of wolves and dogs on the ground, served by boys, and make fires on which there are pots and spits of flesh. They honour brave men with better meat, as the poet says, was given to Ajax when he conquered Hector. They invite guests, asking them after supper who they are and whence they came.§ After supper the war of words ends with a fight; they are regardless of life. They believe in transmigration of souls and throw writings on the funeral pile, as if the dead could read. He then enters into minute details as to their manners and customs in battle, the names and forms of their weapons, and their manner of using them. Some are so regardless of death that they fight naked. They praise their own brave and depreciate their enemies. He relates how they deal with and preserve their dead enemies and booty; their songs and hymns; and unwillingness to part with their dead foes, an action which they ridicule and consider savage and unmannerly. To strike terror they wear vari coloured garments, unshorn, called "Braccæ." Their little cloaks of strips are thicker in winter, finer in summer. Earthen vessels are ornamented with flowers. Their shields are as a long as a man, and adorned to suit the taste; some having brazen figures of animals in relief for ornament and safety. Lofty brazen helmets on which horns are printed, or the images of animals engraved, protect the head. They have barbarous sounding horns.* Some use iron breast-plates, some fight naked with the natural weapons. Some have long two-handed swords hanging on the right by a brass chain. Their iron lances are a cubit or more long, and two hands broad. Their hunting poles have sharper points than swords. They have straight and curved swords, to stab or cut. Their aspects are terrible, their voices grave and stern.. Their words are few, obscure, and doubtful; they boast of themselves and despise others.† They swagger and detract, inflated in their own opinion; they have good abilty, but little of other men's learning. Their bards are musical poets who sing with lyre-like instruments, in praise or dispraise. Philosophers and theologians, called Saronidæ, are much reverenced. Divines foretell by auguries and sacrifices, many think all obey them. While consultiug on important events they keep a wonderfui chatter. By the fall of a stabbed man, the tearing of his limbs and flow of blood, by ancient observations, they know future events. No sacrifice without a philosopher, sacred rites should be by those of divine nature as nearer the Gods, from whom benefits may be obtained by such intercession. By their advice, peace and war are made. Poets have so much influence, that even when the army have thrown their darts and drawn swords, not only friends but enemies cease fighting at their intervention; so that though unmannerly and barbarous, anger yields to wisdom, and Mars respects the Muses.

Can there be any doubt that Diodorus was for some time amongst them, that he was a careful observer, or that he saw the Channel Islands?

131. Having now given the reader the best means in my power of judging of the paragraph in the next artic'e, I proceed to lay a faithful translation before him. The original Greek is quoted in the M.S. Appendix, pure and simple. It is copied from Lib. V., par. xxii., p. 267, Carolus Muller's edition, 1842. The passage is exactly the same, word for word in Stephens's edition, who first published the original Greek of Diodorus. The "various readings" are of no importance to the present purpose. The following particular description, of which the first half is somewhat abbreviated, proves that Diodorus either was in Britain personally, or at all events that he had access to *good* information, perhaps from the tin merchants; else whence so much detail? He says: neither Bacchus nor Hercules contended with the Britons in battle, Cæsar first conquered them and made them pay tribute. There is a promontory called Carion,‡ where it approaches nearest the continent, and another promontory called Belerium, four days sail from the continent. He then describes the form of the island and the length of its sides, and says the Britons use chariots in battle, like the ancient Greek heroes. They have very compact dwellings built of reeds or wood. They lay up corn in the ear, daily grinding enough for use. Their manners are simple, they are honest, and far behind our people in cunning and quick-wittedness. With food simple and of little value, they pass a life estranged from the pleasures of wealth. The north air is cold; they have many kings and princes keeping the peace by turns. But we will speak more particularly concerning these things when we come to the acts of Cæsar by which he subdued the Britons. Unfortunately Diodorus's account of these things is one of the lost books. The following paragraph (Article 132) immediately follows that of which an abstract has just been given. The reader's attention is specially invited to the passage which I have marked in italics, and which being evidently parenthetical, has been enclosed in parentheses, aud a few

* "Cæsar de Bello Gallico," Book IV., s. 17, 18; or in some editions, s. 15, 16.
† Book VI (V. in some editions) chapter 9.
‡ See Brit. Ass. report of the Birmingham meeting, 1865. Trsns. of Sections, p. 77.
§ No doubt Diodorus himself was thus questioned.

* There is still a custom of blowing horns made of shells or cows' horns, on St. John's eve and on other occasions. They are also used to give warning before blasting rocks.
† See "Cæs. Com.," Book III,, s. xviii.
‡ Kent.

remarks will be made afterwards. Immediately after the words "acts of Cæsar by which he subdued the Britons," we have as follows :—

132. "But now we will relate concerning the tin produced there. They who inhabit the promontory of Britain called Belerium, are exceedingly hospitable, and on account of the merchants being their guests, are civilised by custom in their mode of life. They procure the tin by ingeniously working the earth producing it, which being rocky has earthy veins in which working a passage and melting (the ore) they extract (the tin). Forging it into masses like astragals, they carry it into an island situate before Britain, called Ictis. For the middle space being dried by the ebb, they carry the tin into this (island) in abundance, in carts. (*But a certain peculiar thing happens concerning the neighbouring islands lying in the middle* (μεταξυ*) *between Europe and Britain, for at full sea they appear to be islands, but by the reciprocation of the ebb of the sea and a large space being dried they appear peninsulas.*) Hence the merchants buy (the tin) from the inhabitants, and export it into Gaul. Finally, proceeding on foot through France in thirty days, they carry it in sacks on horses to the mouth of the river Rhone. We shall be satisfied with these statements concerning tin."

(*To be continued.*)

STEAM LIFEBOAT LAUNCHES.

We have from time to time drawn attention to the various practical improvements in lifeboats which have been introduced by Mr. John White, of Cowes, who has devoted many years to the study of the important question of the construction of a thoroughly seaworthy and reliable lifeboat, and has been rewarded for his patience and application in the success which has attended the introduction of his lifeboats (Lamb and White's Patent), wherever they have been tried even under the most disadvantageous circumstances.

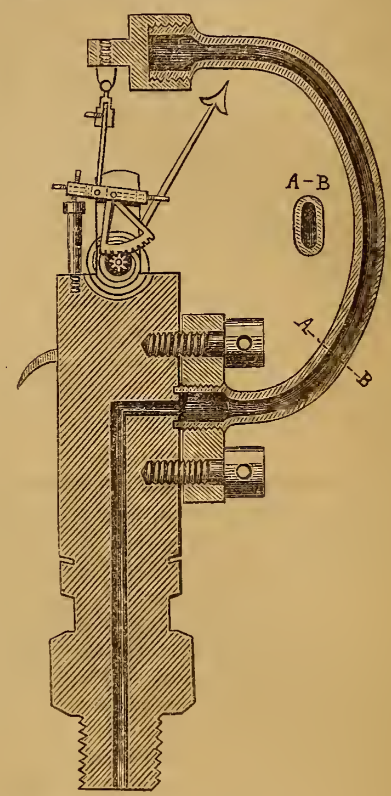
Following up this success, Mr. White some three years since introduced the employment of steam power and a screw propeller for the propulsion of lifeboats, so as to render them available not only as lifeboats proper, but as steam launches or tenders to ships of war and other vessels for the transport of troops, passengers, etc.

We are glad to find that Mr. White has been successful in having received from the present Controller and Chief Constructor of the Navy a recognition of the merits of his invention, which has been taken up by the Admiralty, and we have therefore now in our Navy H.M.'s screw sloop surveying vessels *Sylvia* and *Nassau*, with boats supplied to them which are not only steam launches possessing all the excellent qualities of lightness and speed, but are also lifeboats. The *Nassau's* boat is 27ft. long, 7ft. 3in. broad, and 3ft. 2in. in depth. The hull is built of mahogany of two thicknesses, the inside worked diagonally, and the outside thickness fore and aft. Capacious air trunks run fore and aft on each side of the boat. Upon a recent trial of the last-named boat, the draft of water was 1ft. 10½in. forward, and 3ft. aft; midship section, 14·2 square feet displacement, 10·57 tons. The speed was 6·722 knots, with exceedingly little vibration, and the consumption of fuel, at this rate of steaming, was estimated by the officers conducting the trial at not more than ½ cwt. per hour. In testing her qualities as a lifeboat extra men were taken on board, making up a total of thirty people, in addition to all her other weights, and the water then let into the boat; but even under these severe conditions the water would only flow to the under side of the thwarts, and the boat remained suspended by her air-tubes and casings, with her gunwale 9in. out of the water. The last experiment made was with 15 men standing on the boat's gunwale—the water still having free admission to the interior of the boat—when the water could only be brought within 1½in. of the gunwale's upper edge. This concluded the trials, which were pronounced by the officials to have been throughout exceedingly satisfactory and interesting. A boat on the same principal as those supplied to H.M's ships, *Sylvia* and *Nassau* has been also built by Mr. White for his Royal Highness the Prince of Wales.

* Properly, *in the midst*. See Liddle and Scott's Lexicon. The italics are theirs.

HYDRAULIC PRESSURE GAUGE.

The accompanying engraving is an illustration of a hydraulic pressure gauge constructed by the well known firm of Schaeffer and Budenberg, upon Bourdon's principle modified to suit pressures, reaching to five tons per square inch. The majority of our readers are, no doubt, aware that Bourdon's pressure gauge is based upon the property possessed by an elliptical bent tube closed at one of its extremities to uncoil itself when an internal pressure is applied by the medium of some fluid substance, such as water or oil; and the degree of sensitiveness of the instrument depends upon the following two things simultaneously, namely, the length of the coil and the thickness of the metal of the tube.



For very high pressures, such as are transmitted by the hydraulic press, considerably less sensitiveness is required than for steam purposes; and for this reason Messrs. Schaeffer and Budenberg have reduced Bourdon's coil, which has a length of about seven-eighths of a circumference, to half a circumference only; and the tube, which in Bourdon's gauge is made of burnished brass, is in this gauge made of solid steel bored out to the shape shown in cross section. The loose end is made tight by means of a brass nut screwed upon it, and the joint, with the piece which screws to the hydraulic pump or press, is made good by letting the tube slightly into it. A small connecting rod, articulating in a socket joint, is attached to the loose end, and communicates motion to the index by means of a small crank, quadrant, and pinion; a light hair-spring is attached to the index, in order to prevent back lash.

Messrs. Schaeffer and Budenberg have provided these gauges with a contrivance, very simple in its construction, for registering the maximum pressure which has been attained, by means of a loose index which is pushed forward by the principal index, but catches, by means of a small lift, in a kind of ratchet-wheel cut on to the centre of the dial-plate, and, if the gauge is locked, it must remain in the position to which it has been pushed until the person in possession of the key moves it back.

The fluid used in these gauges for transmitting the pressure is oil, with which the tubes are filled, the advantage of oil being that it does not corrode the tube so readily as water.

These gauges have been applied with complete success, more especially in oil mills, and, among others, at the Copenhagen Mills, at Limehouse, and at Messrs. Blundell and Co.'s mills, at Hull. They are now coming into extensive use.

INSTITUTION OF CIVIL ENGINEERS.

At the meeting on the 20th Nov., the discussion upon the two papers, read at the previous meeting, on the "Results of the Use of Steam Power on Canals," occupied the whole of the evening.

The facts elicited had reference principally to the engine boat "Dart," the property of the Grand Junction Canal Company, to the system of steam haulage on the Aire and Calder Navigation, to the relation between the size of the vessels and the dimensions of the waterway, and to the draught of the vessels in proportion to the depth of water in the canal. Some particulars were given of experiments on Irish canals, commenced in the year 1836, the object being to get a vessel of the smallest beam and the least transverse section of displacement, so as to offer the minimum resistance in the narrow water of the canals. It was remarked that the depth of disturbance of the water, by the wave produced in a canal, or the depth to which it could have any effect in injuring the banks, could not be more than from 2ft. to 3ft.; from which it was thought, that if at the edges of the canal vertical walls were constructed, and the depth increased at the sides to about 4ft., no injury to the bottom, or the channel, could arise from this cause.

At the meeting held on the 27th Nov., the first paper read was "On the Smelting of Refractory Copper Ores with Wood as Fuel, in Australia," by Mr. J. L. Morgan, Assoc. Inst. C.E.

The Ophir Copper Mining Company, being compelled to smelt at their mines the ores of low per centage, which were very silicious, containing little iron or other matter favourable to the formation of a fluid slag, erected a melting furnace, the chief peculiarities of which were the materials used in its construction. Thus, in place of ordinary fire-bricks, quartz—refractory as far as fire was concerned, and not less so when any attempt was made to shape it for the bricklayer—mined as best it could be, was put into an old furnace, kept red hot for forty-eight hours, and then raked into "boshes" of cold water. It was now easily pounded into small particles, so that when mixed with a proportion of clay wash, it could be moulded into a brick. For the false and working bottoms, a sandstone belonging to the Silurian system was used, which was discovered to be capable of withstanding a white heat, and when quarried was easily dressed. The area of the grate was made equal to that of the ordinary Swansea melting furnace, and the body of the furnace considerably smaller—precautions that proved to be unnecessary, for a more intense heat was obtained from the combustion of wood than would have been from first-class coal. It was observed, however, that the cold air had a tendency to form pipes, or passages, between the ends of the logs and the sides of the fire chamber, which greatly diminished, and occasionally almost neutralised, the heat produced from the legitimate combustion of the fuel. To obviate this, dead plates, or shelves of cast iron, were placed round the fire chamber, at the level of the fire bars, and projecting fully 6in. into the area. The ore, although now subjected to a greatly increased heat, still continued intractable. Limestone was added, with partial success; but it was not until iron—a deposit of which was subsequently found at the back of a copper-lode—was added, in proper proportions to the charge, that a fluid slag was produced, from which the copper readily separated itself.

It was stated that the quartz bricks answered admirably; but that the sides at the bridge were considerably worn. This was accounted for from the diminished area of the passage through which the flame of the grate reached the body of the furnace. For example, a volume of flame or gas rose from a grate say 16 superficial feet area, was made to pass through an opening of less than 6ft. area, and then to expand at the middle of the body of the furnace to nearly 15ft. area. Though the author believed this practice to be universal in reverberatory furnaces, he considered that it must be wrong.

The second paper read was on "Light Railways in Norway, India, and Queensland," by Mr. C. D. Fox,, M. Inst. C.E.

By the term "Light Railway," the author states that he had in view such as, either being branches from existing trunk lines, or being intended for districts requiring the development of their traffic, might be constructed in a substantial manner, but with every part only of sufficient strength to carry loads represented by the rule, that no pair of wheels should have to bear more than 6 tons. This would enable these lines to take the rolling stock of all other railways of similar gauge, with the exception of the locomotives.

The railway system of Norway was, it appeared, being constructed on the light principle, with a guage of 3ft. 6in., under the direction of M. Carl Pihl, the state engineer. Two lines had already been completed; the one, from Grundsett to Hamar, a distance of 24 English miles, at a cost of £3,000 per mile, including rolling stock and stations; and the other, from Trondhjem to Storen, a distance of 30 English miles, at a cost of £6,000 per mile, including also rolling stock and stations; but in the latter case the country was more difficult, the works generally were heavy, so that steep gradients and sharp curves were unavoidable. The details were given of the locomotive and carriage stock; and it was observed, that these lines, which ran through thinly populated districts, already more than paid their expenses; and that the results of their working had been so satisfactory, that this system was being extended.

In India, a line from the Arconum junction of the Madras railway to the town of Conjeveram, 19 miles in length, and on the same gauge of 3ft. 6in., had been at work for eighteen months. This had been constructed for £3,500 per mile, including telegraph, stations and rolling stock; and although the traffic did not require a greater working speed than from 12 to 15 miles per hour, the trains had at times been run, with perfect safety, at upwards of 40 miles per hour, including stoppages.

For the Government railways of the colony of Queensland it was decided, after much discussion, to adopt a gauge of 3ft. 6in Of the Southern and Western railway 50 miles had already been opened, while 124 miles were in course of construction, and 200 miles under survey. The little Liverpool range on this line was 3 miles in length, had ruling gradients of 1 in 50, and curves of 6 chains radius. The main range was 15 miles in length, had ruling gradients of 1 in 45, and frequent curves of 5 chains radius. One of the chief works was the bridge over the Bremer, close to the Ipswich terminus, for carrying a single line of narrow gauge railway and a public road 25ft. wide. It had a width of 37ft. between the parapets, and consisted of three spans of 150ft. each. The superstructure was composed of lattice girders 12ft. deep, the top flange being of cast iron in a tubular form, and the bottom flange Howard and Ravenhill's rolled links; the total weight was only 12 cwt. per lineal foot of the bridge. The stations and passenger rolling stock were then described. It was stated that three classes of locomotives were used; tender engines, weighing 15 tons in working order, upon six wheels, four of which were driven, which were employed on the easiest portions of the line; a similar kind, but weighing 20 tons in working, upon eight wheels, six of which were driven, for the little Liverpool incline; and the third, on Fairlie's principle, for use on the main incline, had two bogie frames, each supported upon six wheels—and connected with the boiler, which had a smoke box at each end—by central pins, and with a central fire-box by slotted quadrants having studs working in them at each end of the fire-box. There were thus twelve wheels, all of which were drivers, but the central pair in each group was without flanges. The weight of the engine in working order would be 30 tons, and it was calculated, that it would take 120 tons of gross load, at a speed of 15 miles an hour, up an incline 15 miles in length, having ruling gradients of 1 in 40, and frequent curves of 5 chains radius. The cost of each engine free on board in England was £2,500. In designing these several classes of locomotives, care had been taken to keep down the weights, to provide ample heating, and fuel and water space; to have fire boxes to burn fuel, consisting of two-thirds of wood and one-third of coal; to supply great break power, and to shelter the driver from the heat. To enable the engines to pass round curves of sharp radii, and for obtaining elasticity between the rail and the wheel, the rigid wheel base in no case exceeded 7ft. 2in., and all the engines were fitted with the best springs, and with Adams' spring tyres, the tyres being cylindrical and not coned. Some account was then given of the character of the permanent way, and it was stated that these lines might be constructed under difficult circumstances for between £11,000 and £12,000 a mile, and under ordinary circumstances for £6,000 a mile, including stock and appliances of all kinds.

The Great Northern Railway of Queensland was then noticed; and in conclusion the author repeated that, in his opinion, the basis of the Light Railway system was—the reducing of the weight upon every, even an engine, wheel in the train to 3 tons, the limitation of the speed to 25 miles an hour, and the adaptation of every detail to this data. The importance of this system would he believed, before long be found to have much influence upon railway construction for branch lines, both in this and other countries, especially where the traffic was limited, and where high speeds were not demanded.

On the 11th ult. the paper read was "On the best means of Communicating between the Passengers, Guards, and Drivers of Trains in Motion," by Mr. W. H. Preece, Assoc. Inst. C.E.

In this paper the author gave a history of the measures which had been taken, in England and in France, with a view to the establishment of some means of communication between the passengers, guards, and driver of a train in motion. It was stated that although the question was still in abeyance in England, the railway companies were taking active steps, by experimental and practical trial, to secure an effective system of passenger signals. The limited mail and fast express trains frequently ran 80 miles and upwards without stopping; and the tendency was even to extend this limit. Under these circumstances passengers might be confined, in helpless isolation, for two hours or more, and cases had occurred, where a disabled carriage had been dragged 20 or 30 miles, without the occupants being able to attract attention. The necessity of some communication was fully admitted; but while it was allowed that there was no mechanical difficulty to be overcome, the objection, that had hitherto prevented the introduction of any general system, had been the unwillingness of the railway authorities to place control of the trains in the hands of the passengers, by which, it was thought, delays might be occasioned, and danger be created. The block system removed, to a small extent, the danger of stopping trains on busy trunk lines; but, at present it was rarely adopted. Experience showed that the objections referred to were exaggerated, as several trains had been running uninterruptedly for nearly two years upon the London and South Western line, fitted up with passenger signals, and a needless alarm had only once been raised, and then the delinquent was immediately detected.

The efforts of those who had directed their attention to the matter had been not merely to obtain communication between passengers and guards, but some means of access for the guard to the passengers. It had been proposed to establish a foot-board and hand-rail upon every carriage, to enable the guard to patrol the train whilst in motion, but the objections to this system were insuperable in England, as external circulation was neither practicable nor desirable. Internal circulation, upon a modified arrangement of the American plan, had been suggested. The objections to this were detailed, and the system of dividing the compartments by glass partitions was described as an instalment towards this result.

Failing the adoption of any system of internal or external circulation, it was pointed out that what was required was, that the instant attention of the guards and driver should be obtained to anything of a serious nature occurring to any portion of a train whilst in motion, requiring their immediate assistance. The insufficiency of travelling porters, mirrors, and other systems requiring constant personal inspection was shewn; and the mechanical difficulty of utilising the present cord and bell which even in its simple form between guard and

driver alone, had proved comparatively useless in practice, as well as any mechanical contrivance exteuding the whole length of the train was urged.

Attempts had heen made to isolate the alarm to each separate carriage, and thus to avoid the difficulties of the couuections and couplings of mechanical contrivances reqnired in the making up of a train. The use of compressed air, and other pneumatic arrangements; the utilisation of the violent current of air generated hy the moving train; immense gongs on the carriagc roofs; fireworks, detonating signals, powerful lights, and varions other proposed apparatus, were described, and their causes of failure alluded to. Indeed the almost unanimous conclusion, both in England and in France was, that if the problem was to be solved at all it must be hy the aid of electricity. There was no force so ductile, so simply generated, aud so easily manipulated. It was obstrncted by no friction, like mechanical motion; it required no powerful appliances to restrain its action, like steam; it demanded uo tubes, pipes, valves, cranks, or other mechanical agencies to guide it, like water, gas, or air. All that was wanted was a plain wire, that might he laid or hent in any direction, needing only the simplest contrivance to retain it in its course. The laws and the action of electricity were thoroughly understood. There was no tension, and consequently no breakage; there was no motion, and therefore no sticking of parts. The necessity of delicate machinery, which the supposed subtlety of the force demanded, no longer existed. Experience showed, that the stouter aud more durable, within certain limits, the mechanical construction of electrical apparatus, the better it worked. Indeed, the oscillation of a railway train was eminently adapted to maintain those surfaces bright and clean, upon which the passage of the electric force materially depended.

The history of the trial of electrical appliances, from their first proposal in 1842 to the present time, was hriefly narrated, and a description was given of the system, applied by the author, on the midland, the Great Northern, and the Londou and South Western Railways. The essential principle of this system was the extension of a siugle insulated wire throughout the whole train, which was maintained in a state of electrical eqnilibrinm by having the similar poles of every battery in each vau and eugine attached to it, while their opposite poles were connected with the earth; so that when this eqnilibrium was disturbed, hy placing the wire to earth through the framework, wheels, and rails in any carriage or van, the current from each hattery acted upon the bell in its own van, and upon a signal on the engine. Its peculiarity consisted in this, that the commutators in each compartment of every carriage were protected, from the mischievous and idle, by being covered with glass, which had been found experimentally to be the best material for the purpose, as any opaque substance excited inquisitiveness, and therefore interference. The conpling used was an ordinary hrass hook and galvauised iron eye, maintained in good contact by the pressure of a stout spring. It was divided into two parts, not only to provide for the reversal of the carriages, hut to enhauce the security of the couplings, from failure in electrical connection, as experieuce had shown, that a single coupling was not to be depeuded on. The author used the ordinary description of trembling bells, which continued to ring as long as the current was maintaiued, and which were equally applicable for any code of signals that might be determined upon. They were, however, specially constrncted to prevent any emission of sound arising from the oscilliation of the train. It was originally contemplated to provide external visible semaphore, as well as an external electrical signal; but this had latterly been abandoued. In the system at present in practical work, there was free intercommunication between guard and guard, between the guards and the driver, and between the passengers and the guards. It had been found that no bell, however loud, could be heard upon the engine. The driver was therefore provided with a signal, which attracted his attentiou hy a red disc by day, and a red light by night. There was also a special arrangement, by which carriages accidentally detached from a train automatically raised the alarm, so that intimation was at once given to the guards and to the driver of any accident; aud it was arranged, that the ordinary slip portion of the train, where such slips were employed, dropped off without raising the alarm. It was shown that a train might be made up of auy number of coaches, might be divided into any number of parts, and might be united again at auy number of junctions, without interruptiug the communication, provided a van aud a carriage remained together.

In conclusion it was stated, that the experience gained from the working of this system showed, that whatever difficulty existed in establishing a system of communication betweeu the passengers and guard, was merely a mechauical one, and that any danger, or inconvenience, from placing snch a convenience in the hands of the passengers was purely chimerical. The control of the train was in no case withdrawn from the servants of the railway company. The passengers simply attracted the attention of the guard, who exercised his owu discretion, whether the train should he stopped at once, or when it arrived uuder the protection of the next fixed signals.

INSTITUTION OF ENGINEERS IN SCOTLAND.

At the opening of the present session, Mr. J. G. Lawrie, the president, delivered the following introductory address, to which we gladly give a place by reason of the admirable *resumé* which it furnishes of the recent progress of scientific engineering:—

In resnming business this session we have reason to be encouraged to continued industry by the success which attended our labours last session.

During last session we had papers on the strength of materials that are extensively used hy engineers; papers explanatory of certain ingenious mechanical contrivances; papers on the propulsion of ships; papers on the mode of perfecting the action of certain tools and instrnments; papers on the strength and construction of ships, both iron and composite; papers on the construction of ships with reference to sea-worthiness; papers on new applications of iron, and on the most efficient mode of using iron in various structures; papers on the policy of certain laws affecting shipping property and those who use it; and, besides, papers on various other subjects.

The papers on these subjects, and the discussions which followed, were of great value to the engineer. Throughout these papers and discussions the desire plainly was to treat the subjects both practically and scientifically, and to consider them in a way dictated by a knowledge of principles rather than empirically. Several of the subjects of these papers were of singular interest and importance. Of these there is, perhaps, no subject that better merits the attention of such institutions as this than the construction of ships in respect to sea-worthiness, and we have reason to be gratified with the reception that our views on this subject received in the most influential quarters. Our attention was particularly drawn to this subject by the recent occurrence of diasters at sea, attended with the most lamentable results in the loss of human life; and the views which we persistently advocated to the Government in a contemplated change of the Board of Trade regulations, would certainly have already hecome law but for the change of Ministry at the time. The delay will, however, we believe, he only temporary.

We trust that hy continued perseverance during this and future sessions the proceedings of this Institntion will ever be of equal interest and utility; and that an important object of the business of this institution will always be to trace the relation of practical mechanics and scientific principles, and to investigate in what way the operations of the engineer cau be advanced by the application of pure science, so that in the performance of the work which he seeks to accomplish his progress may be the resnlt of an intelligent application of Nature's laws.

The progress of scientific engineering has of late years been rapidly extending, and has received dnring last summer a most signal illustration in that great work, the Atlantic Telegraph Cable. The accomplishment of this work, the construction and the laying of the cable, required a greater breadth of scientific engineering than any other that has, perhaps, ever been performed. The design of the cable required an extensive acqaintance with the principles of that subtle and powerful agent, electricity. The construction of the cable required an experience, the result of many years' practical study, at an expense measured by millions sterling; and the task of layiug the cable could not have heen accomplished at all without the assistance of these powerful machines, steam ships, which involve a knowledge of the principles of steam. Thus, without a knowledge of the principles of electricity, without a knowledge of steam, and without a mechanical ability to carry into effect the requirements of these scientific principles, the electric cable could never have been made, nor could it ever have been laid across the Atlantic. No engineering work has certainly ever been performed of a higher character, not only iu the result sought to be attained, but in the means employed for its attaiumeut. To recapitulate the process and progress through which this great work has been accomplished is unnecessary in this place, as scarcely anything can be added to the copious information on the subject supplied in the public prints. Familiar as we are, however, with the various steps through which this work has passed, and simple as they now appear, no words can express the wonderful advautage of the results which this work is destined to confer. Wherever and whenever the action of mankind is based upon information possessed, the means by which distance—the impediment hitherto to the transmission of information—can be eliminated becomes of paramount importauce. No man can be engaged in the bnsiness and pursuits of life without desiriug at times expeditious communication with those at a distance, and by the electric telegraph a correspoudence amounting to a conversation is easily affected with an economy of time that it is impossible to calculate. The electric telegraph not only quickens the steps of events by quickening the transmission of information, but introduces at the same time an altogether new aud in a sense opposite element in the progreas of events, by arresting, as it were, their passage, which but for the telegraph would have gone out of reach before they could be otherwise utilised. This compound advantage of the telegraph obtains in the whole intercourse of the human family. Events are not only hastened by its means, but, hy the more perfect information it gives, other events are crowded forward, for which no motives would otherwise have existed.

The success, hoth physical and commercial, that has attended the Atlantic cable, puts it now beyond a doubt that all populous places on the globe will very shortly be within almost instaut reciprocal communication.

Snch is the memorable result attained iu this the greatest effort of scientific engineering in modern times. Other recent illustrations, however, are uot wanting to show the services rendered by science to the engineer, and of these iu the instrument which has recently received so much attention, and which is now popularly called the needle-gun, these services are prominently apparent. The transition iu point of utility from the muzzle-loading flint-gun to the breech-loading needle-guu is scarcely less than from the stage coach to the railway train. The stage coach is of no use whatever when within reach of a railway train, nor is the flint-gun of any greater value iu comparison with the hreech-loading needle-gun. Upon the railway train depends almost the existence of modern commerce, and upon the needle-gun depends to a considerable extent apparently the fate of modern warfare. The effectiveness of the British needle-gun depends upon the efficient breech hy which breech-loadiug is rendered satisfactorily attainable; it depends also upon the construction of the cartridge, which is made to explode hy a part of the end being indented; and it depends upon the coating of the cartridge which prevents the fouling of the harrel. In this cartridge no opening iu the case is necessary for the explosion to be produced, hut simply that a part of the case be indented inwards, and hence the certainty of the explosion when desired. In other cartridges, as in that used in the well-known Prussian ueedle-guu, the cartridge case requires perforation, which opens the way for the admissiou of moisture, and iutroduces uncertainty in the explosion. For the production of this gun—the British needle-gun—the

services of the scientific engineer are indispensable to elucidate the construction of the barrel, the construction of the bullet, and the construction of the necessary cartridge, without which efficiently constructed the barrel and the bullet, though perfect in themselves, would be wholly a failure. The rude instrument by which a bullet may be thrown by the explosion of gunpowder is a very different one from the British breech-loading needle-gun; in the latter, the rifle barrel is a highly ingenious contrivance to give the bullet a rotation round a longitudinal axis, in order to prevent rotation round any other axis which would cause the bullet to deviate from a direct path, or, rather, from a perpendicular plane passing through the bore of the barrel. The construction of the bullet, having its centre of gravity properly situated in relation to its figure, is no less essential in order that the bullet may travel in the proper trajectory, with a minimum disturbance from the action of the atmosphere. The construction of the cartridge, by which the explosion being effected without perforation of the case, and without external fire, is of paramount importance, in order that the action of the gun may be independent of the weather or moisture. The coating of the cartridge, which is contrived to prevent the fouling of the barrel by the passage of the bullet or by the explosion, is essential, in order that the gun may not become useless in action; and, lastly, the gunpowder—both that which projects the bullet and that which produces the explosion—have all been subjects of scientific investigation, and the results of scientific knowledge.

Another illustration of the services rendered by science to the engineer exists in the modern improved steam-engine. Great as were the advantages derived from the original form of the steam-engine, in which the same vessel performed the duties of steam cylinder and condenser, it is nevertheless an instrument immensely behind the modern engine. The invention of a mechanical prime mover, which should be independent of the action of the wind, and which, not being fettered to situations where falls of water existed, could be placed anywhere and extended indefinitely, possessed plainly advantages wholly unattainable without such a prime mover, and was therefore fitted to produce an entire revolution in operations dependent on the exertion of dynamic force. Beyond the applications falling within the scope of a prime mover, such as the original form of steam-engine, there existed even a wider range to which such a prime mover could not be profitably applied, and which consequently were as entirely shut out from that class of prime movers as if it had not existed. For these the more perfect instrument in the modern steam-engine is peculiarly adapted. In steam navigation, for example, the improved steam-engine is rapidly becoming indispensable. For that purpose the difference betwixt an engine which uses 4½ lbs. of coal per horse power per hour, and one which performs the same work with 2 lbs., is so great that in many cases while the one is very much what the circumstances and conditions require, the other is absolutely worthless. With the former the expense of the fuel would alone in many cases be a bar to its use; but when to the expense of the fuel is added the incompatibility of burning 4½ lbs. of coal per horse power, with the requirements for carrying cargo, the application of such a prime mover is wholly out of the question, and brings into prominent contrast the advantages of the latter. And these advantages are most prominently services rendered by science to the engineer. The advantages obtained by expanding the steam, the advantages of surface condensation, and the advantages of moderate superheating, which constitute the improvements of the modern steam-engine, are due altogether to the scientific engineer. No one of the three has been the result of accidental observation, but has been due to elaborate and patient investigation. It is true that the amount of advantage derived from any one or all of these improvements has not yet been by common assent definitely ascertained, the experience of different engineers showing different results, arising, probably, to a large extent from inaccuracy of observation, and also to the different modes by which the advantages are sought to be arrived at. While, however, these different results are being discussed, questioned, and not unfrequently discredited among the doctors, the users of the steam-engine, the public, are plainly in practice answering all doubts by a steadily-increasing demand for the improved steam-engines, showing that although different forms may yield different amounts of advantage, they all, in every practicable form, yield results of sufficient advantage to induce their extended application. The progress made by these improvements points palpably to the time, and at no distant period—within, probably, fifteen or twenty years—when in steam navigation, for every work, except it may be the shortest coasting voyages, the injection condensing steam-engine will be entirely obsolete. On a vast variety of stations the question is not one with a consumption of 4½ lbs. of coal per horse-power of more or less profit, but it is whether there is to be or there is not to be steam navigation at all, and the advantages of steam navigation compared with sail navigation are so tangible and so great as to insure the unremitting attention of engineers to the entire removal of the remaining difficulties in the way of the improved steam-engine. The great ocean race from China, which has received so much notice within the last few weeks, and which reflects so much credit on the shipbuilders of this neighbourhood, whom we are proud to number in our list of members of this institution, will, undoubtedly, in a very few years, lose its prominence, and be eclipsed by a race of far higher speed.

The great and prominent improvement in the steam-engine, as applied more particularly to steam navigation, is the economy of fuel, and without that improvement all the others that have been made would have been worthless, but with that improvement others have been of immense value, as in the change from the paddle wheel to the screw propeller. For many services, the paddle wheel was a most clumsy, inconvenient, and undesirable mode of propulsion. For all services, except as yet, in shallow water, the screw propeller is nearly all that can be desired.

Recently, however, a method of propelling ships by the reaction of water issuing from turbine water wheels, now commonly called the Ruthven mode of propulsion has been revived, and has lately been tried in one of her Majesty's ships, the *Waterwitch*.* This method of propelling ships s not without advantages peculiarly its own. For example, in many ships, and perhaps in all, the great power which a ship so fitted possesses in discharging an immense quantity of water, the result, it may be, of a leak or injury, is of no inconsiderable importance. Probably, a facility of manœuvring a ship so fitted is another advantage. But there are no good grounds for believing that this mode of propulsion will be more economical in the application of dynamic effect or power, or in fuel, than the screw propeller, nor even that it will be so economical. In a comparison of the two modes of propulsion, there are three elements which fall to be considered:

1st. The consumption of the power of the machinery due to the friction of the propelling instrument.

2nd. The consumption of the power of the machinery due to that part of it which is carried off by the water projected from the ship.

3rd. The consumption of the power of the machinery due to the propulsion of the ship, or that is developed in the propulsion of the ship.

To compare minutely the friction in the two methods, it would be necessary to know the surface, in each case, of the propelling instrument; in the one case the surfaces of the screw propeller, and in the other the surfaces of the turbine wheel and the surface of the water passages. Even, however, without these measurements, it is plain that the screw propeller has the advantage to a large extent in this respect. The surface of the propelling instrument itself is manifestly in favour of the screw propeller, and the loss arising from the friction of the water in the water passages with the turbine wheel has no counterpart at all with the screw propeller.

With regard to the consumption of the power of the machinery in that part of it which is carried off by the water that is projected from the ship, it is to be observed that with the screw propeller, if there be a sufficient number of blades, the whole water in the cylinder, of which the diameter is the diameter of the propeller, and the length the speed or space passed through by the ship, is driven off with a certain speed which measures the reactionary power obtained in that way for the propulsion of the ship. If this cylinder be reduced in diameter the water must be driven off with a higher velocity to maintain undiminished the reactionary power derived from that source; and, inasmuch as the power carried off by the water and wasted not being developed in the propulsion of the ship increases as the square of the velocity, plainly the higher the velocity with which the water is projected from the ship the greater the power carried off to waste. Consequently in this respect the turbine wheel plan, adopted in the *Waterwitch*, in which the discharge orifices are of small dimensions, comparatively, and therefore, the velocity with which the water is projected necessarily considerable, is inferior to the screw propeller.

With respect to the consumption of the power of the machinery due to the propulsion of the ship, it is to be observed that with the screw propeller the power of propulsion is derived from two sources—the one being the reaction due to the water which is projected backwards from the ship, and the other due to the reaction of the water in having imparted to it the velocity with which it is projected from the ship. For example, suppose the ship be propelled through the water by a propeller working in a solid, as it could be by having for illustration a propeller shaft of great length, then all the power of the machinery, with the exception of that required for friction, would be employed in propelling the ship, and none would be carried off by water being projected backwards from the ship, because none would be so projected. When, however, the propeller works not in a solid but in water, there is plainly reaction obtained for the propulsion of the ship, first from the inertia of the water in having velocity imparted to it, and then there is reaction corresponding to that velocity. The reaction due to the inertia of the water in having velocity imparted to it is measured by the rapidity with which that velocity is imparted, and is represented by a quantity proportioned directly to the velocity, and inversely to the time in which the velocity is imparted, or, in other words, is represented by the expression the velocity divided by the time; and, if, therefore, the time during which the velocity is imparted be reduced to one-half, or one-fourth, or one-tenth, or is infinitely reduced, then the reaction obtained from this source is increased twice, or four times, or ten times, or is infinitely increased—that is, if the propeller imparts the velocity to the water with great rapidity, the reaction will be equal to that of the propeller working in a solid. With the turbine wheel the reaction obtained from the inertia of the water in having velocity imparted to it is plainly much inferior to that obtained with the screw propeller.

In all the three elements the screw propeller appears therefore to have the superiority.

1st. In the friction of the rubbing surfaces.

2nd. In the quantity of power carried off to waste by the water projected backwards from the ship.

3rd. In the quantity of power which is developed in the propulsion of the ship.

And the extent of superiority depends upon the details of the manner in which the two methods of propulsion are carried out.

The *Waterwitch* has already been submitted to a trial on the Thames, and in

* Our readers will also remember that in the Artizan volume for 1863 we gave plate illustrations and a textual description of this system of propulsion as adopted by the Societé Cockerill, of Liege, for one of their steamers plying on the Meuse; this system of propulsion being adopted in the case referred to, not from any recognised merit in the system, but from the circumstance of the shallowness of the stream rendering a screw propeller not so well adapted for giving out the full power of the engines, whilst paddle wheels were objectionable on account of the narrowness of certain points of the stream through which the vessel would have to pass.

We think it right, whilst agreeing generally with the President in his views, to call his attention to the circumstance which we have instanced of the prior application of this system of propulsion.—Ed. Artizan.

the report on the subject which has appeared in the press, the performance has been greatly lauded. The method of propulsion has been praised, and the machinery by which the method has been carried into effect has, as usual with many of our English friends, been also very considerably trumpeted. The facts, however, stated in the report do not afford the means of correct inferences respecting the result obtained, and the further experiments yet to be made are probably desirable to elicit in actual practice the true character of this method of propulsion.

The illustrations which have been adduced to the progress of scientific engineering could be multiplied to almost any extent. Within the last few years engineering has been rapidly changing character. Formerly engineering was not nearly so much as now a succession of scientific improvements. Then it was enough in a sense to be a hewer of wood and a drawer of water, and to travel in a beaten path; but now it is far otherwise, engineering being in all directions full of novelties—the dictates of science. The mode of communication between distant places is, we have seen, entirely new, and is the result of laborious, patient, and keen investigation of the occult laws of nature. The mode of conveyance both by land and sea is full of the use of Nature's hidden laws. The material which the engineer employs is rapidly being changed, stone being superseded by iron, and iron in many applications being displaced by steel, produced in a manner entirely new and due to principles far from obvious. Defining an engineer to be an artificer on matter, the scientific nature of his employment is apparent, whether we consider him as a fabricator of machines for transmitting intelligence or for transporting the fruits of the earth; whether he be considered as a fabricator of food in high agriculture, which is now in reality a manufacture, or as a fabricator of coverings to protect us from the inclemencies of the weather in the beautiful materials now constantly produced; or as a fabricator adapting everything around us, beneath us, or over our heads, to the wants and comforts of man. It is no longer sufficient for the engineer to know by rote the successive steps necessary in the various operations which fall to be performed by him, and which, when known, may all be classed under the denomination of hewing wood and drawing water. He must be acquainted with the principles or laws of nature upon which these various operations depend; he must extend the applications of these principles in new developments if he would seek to keep abreast with the progress of modern engineering. It has been frequently alleged, and correctly so, that the task of deciphering Nature's laws, that is, of becoming scientific, is difficult of performance, and that any action taken upon a misapprehension of these laws is attended with disappointment and disaster. No doubt if erroneous steps be rashly made upon a misconception of the laws of Nature, the result will be disappointment and failure; and in proportion to the rareness of the capacity of correctly understanding these laws is the distinction of doing so, and the value of the reward due to success. These difficulties may furnish reasons for diffidence in undertaking the task, but they furnish no reasons for discrediting or undervaluing the labours of the successful explorers, which an inconsiderate view of the matter has not unfrequently encouraged.

To assist each other in deciphering the laws of Nature, to explain their application, to pick up Sir Isaac Newton's pebbles on the sea shore, and to be enabled to practice our profession of engineer with increasing intelligence, is our object in these meetings.

"The search itself rewards the pains,
So though the chemist his great secret miss,
(For neither it in Art or Nature is,)
Yet things well worth his toil he gains,
And does his charge and labour pay,
With good unsought experiments by the way."

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

At the meeting of the Executive Committee of the Association, Mr. L. E. Fletcher, chief engineer, presented his report for the month of October, of which the following is an abstract:—

During the last month 473 engines have been examined, and 631 boilers, as well as two of the latter tested by hydraulic pressure. Of the boiler examinations, 506 have been External, 5 Internal, and 120 Entire. In the boilers examined 114 defects have been discovered, 5 of those being dangerous, thus:—Furnaces out of shape, 4; fractures, 5; blistered plates, 2 (1 dangerous); internal corrosion, 12; external corrosion, 16 (2 dangerous); internal grooving, 2; external grooving, 1; feed apparatus out of order, 1; water gauges ditto, 17; blow-out apparatus ditto, 13 (2 dangerous; safety-valves ditto, 5; pressure gauges ditto, 4; without feed back pressure valves, 32.

Details of some of the defects mentioned in the preceding list may now be given.

External Corrosion.—Two small Cornish boilers, about five feet in diameter, set upon mid-feathers, and but lately placed under the inspection of this Association, were found on the first examination to be so seriously corroded along the bottom that the inspector readily knocked a hole through one of them with a hand chisel. This boiler has since been repaired, and the width of the mid-feather wall reduced from 10 to 6 inches, while repairs to the other are now in progress.

Another boiler, 8 feet in diameter, was found to be dangerously corroded at the bottom from damp in the flues; and on removing portions of the brickwork, the inspector easily made a hole through the plates.

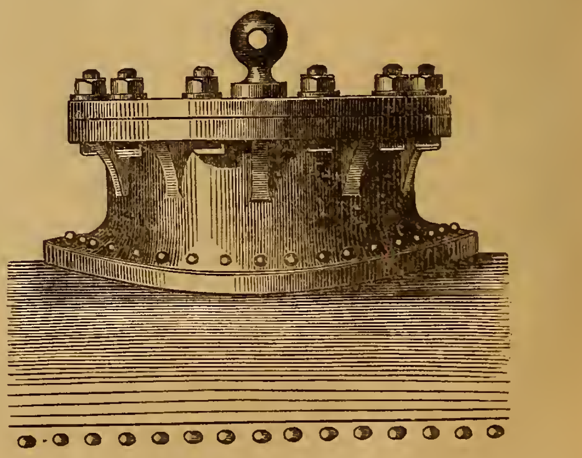
In another case, a boiler 8 feet in diameter was found to be corroded at the bottom of the shell at nearly all the ring seams of rivets, which till recently had rested on a mid-feather, though the boiler is now set on side walls. The boiler was submitted to an hydraulic test of 60lb. per square inch, and, as the inspector was making a flue examination while the pressure was on, and sounding the plates to ascertain the remaining thickness, he tapped a hole through one of them, and was driven out of the flue by the rush of water. The original thickness of the plates had been seven-sixteenths of an inch.

Blow-out Apparatus out of Order.—In this case the cast-iron elbow pipe, between the boiler and blow-out tap, was broken off short, near to the root. The elbow pipe was jammed tight in the brickwork at the front of the boiler, while the tap was an inferior one, being an ordinary plug and of cast-iron throughout. These elbow pipes should never be held fast in the brickwork, since, when this is the case, they are liable to be strained by the movements of the boiler, but the front cross wall should be recessed so as to leave the pipe entirely free; also, inferior taps, which work stiffly, and require a good deal of force to open them, put a very dangerous strain upon these pipes. The fracture was discovered when the steam was down, and, most probably, it had but just taken place. Had an attempt been made to open the tap when steam was up serious consequences from scalding would, in all probability, have resulted.

Strengthening the Manholes of Boilers with Mouthpieces.

The importance of strengthening the manholes of boilers with mouthpieces is shown by the fact that nine explosions, by which fourteen persons have been killed and six others injured, have recently occurred to boilers in which this precaution had been omitted. In each of these explosions the primary rent has started from the manhole, and although in some cases the pressure of the steam has been considerably higher than it should have been, so that the explosions have been partly attributable to excessive pressure, yet they have been materially promoted by the weakening effect of the unguarded manholes, while others have been entirely due to that cause. Particulars of six of these explosions have been given in previous reports; * while those of three others will be found below. The weakening effect of unguarded manholes is not produced solely by the amount of metal cut away, but to a great extent by the action of the covers. These are generally internal, and held up to their work by the pressure of steam as well as by a couple of stout bolts and nuts, suspended from arched bridges; and as the surfaces of the plates at the joint are not dressed smooth but left rough, a considerable strain is frequently put on the bolts to make the joints steam tight, especially when the cover does not fit the sweep of the boiler. Thus the action of the steam, combined with bolts, tends to force the cover through the manhole and split the boiler open. This is just the action that takes place. In some boilers it has been detected in an early stage, just in time to prevent explosion, while others have been known to burst shortly after the manhole covers have been tightened up or the joint caulked. Nothing is easier than to strengthen these manholes. It is done in all modern boilers turned out by first-class makers, so that there is not anything novel about it. As, however, some of our members have old boilers to which this mounting is not attached, and which they are desirous of adding, while some makers continue to turn out new boilers without it—a practice from which so many fatal explosions, as just stated, have already occurred—it is thought that a description and sketch of this most simple but valuable mounting will not prove altogether unacceptable to our members, some of whom indeed have already requested it, and therefore it is now given.

The manhole mouthpiece represented in the accompanying sketch is an external one, made of cast iron, and in the shape of a short cylinder, with a flange both at the top and bottom, the lower one being curved so as to fit the sweep of the boiler to which it is rivetted, while the upper one is flat, and fitted with a cover, secured with bolts and nuts. Both the cover and upper flange should be faced up true on their joint surfaces, while it adds a finish to the work to turn them up on the edge, as well as to face the cover on the outside for a width of about four inches, so as to give a true bearing surface for the nuts. For convenience in lifting the cover, a wrought iron eye bolt should be attached to it at the centre. The height of the mouthpiece should be sufficient



* See in Artizan volumes Association's Monthly Reports. February, 1863, No. 2 Explosion. January, 1865, No. 3 Explosion. November, 1865, No 5 Explosion. December, 1865, No. 43 Explosion. April, 1866, No. 14 Explosion. May 1866, No. 12 Explosion.

to admit of the introduction of the bolts between the flanges for securing the cover, while the opening should be large enough to afford a man easy access, say 15 inches, which however, is a liberal allowance, and might be slightly reduced in special cases should it be desirable to do so. The metal should be an inch and a-quarter thick for steam at a pressure of 60lb., while the bolts should be an inch in diameter, and spaced about six inches apart. It is well to strengthen the upper flange by brackets, as shown in the cut; while the cover can be stiffened by ribs if required. By some makers the flanges are made as much as an inch and a-half thick. For steam considerably above 60lb. on the square inch, mouthpieces are sometimes made of wrought iron, but those of cast iron are found to work satisfactorily up to that pressure. No hemp ring will be required for making the cover joint, but merely a little red lead and oil if the surfaces be properly got up, and provided that the lower flange be suitably rivetted to the shell, little or no caulking will be required to make it steam tight.

This external manhole mouthpiece is not the only form adopted. Some boiler makers prefer an internal one. Either of them if properly made works well. The one shown above is of a type very generally adopted and approved. Many hundred boilers are fitted with it in this neighbourhood. It has been found to work satisfactorily, and may safely be followed.

Mudhole Mouthpieces.

In double furnace boilers the mudhole—which is placed at the bottom of the front end plate, and below the furnace mouths—forms a second manhole, and should be guarded with a mouthpiece. When this is omitted inconvenience is experienced from leakage at the joint, which not only disfigures the boiler, but induces corrosion, in many cases so wasting that the front end plate has to be cut away and repaired. With good mouthpieces suitably got up, this danger is avoided.

The mounting for mudholes is very similar to that recommended above for manholes, but the position below the furnace mouths does not allow room for a cylindrical mouthpiece sufficiently large to admit of a man's passing through it and, therefore, instead of being cylindrical, it has to be oval. Like the manhole mouthpiece just described, one of the flanges is riveted to the boiler, and the other fitted with a cover secured with bolts and nuts, both joint surfaces being faced, as well as the outside of the cover, for a width of about 4in. from the circumference, in order to ensure the nuts bearing fairly. It is important that the joint surfaces should be well got up, and it it better to make the joint with a little red lead and oil, than with a spun yarn ring; while a case which has occurred during the last day or two may be mentioned in illustration of this, in which the furnace crowns of a boiler were both laid bare and overheated at night time, in consequence of the water's wasting away from leakage at the joint of the mudhole cover, which was not made metal to metal with red lead and oil, but with a spun yarn ring. Metal to metal joints will of course sometimes leak if neglected, but they do not give way unawares, and thus rapidly drain a boiler as in the instance just mentioned, while the amount of discharge in all cases may reasonably be expected to be less, even should leakage occur.

Internal mouthpieces are sometimes preferred for mudholes to external, but either one, if well got up, will do good service. Perhaps the external ones are more extensively used, and, as stated above, with regard to the manhole mouthpieces, they are found to work satisfactorily, and may safely be adopted.

Explosions.

Before entering on the explosions of the past month, the particulars of two others, viz., Nos. 27 and 29, which were of prior occurrence, may be given, since they have special reference to the subject of unguarded manholes just alluded to.

No. 27 Explosion occurred at about half-past four on the afternoon of Thursday, May 31st, at a small elastic braid manufactory, and resulted in the death of one person as well as in injury to two others.

The boiler, which was not under the inspection of this Association, was most diminutive, its length being only 4ft., and diameter 2ft. 5in. It was fired externally, and of plain cylindrical construction, with dished ends, the barrel being composed of two plates, which were laid lengthwise, and measured a quarter of an inch in thickness, while the ends are three-eighths.

The equipment of the boiler was most defective. There was a large manhole cut in the top of the shell, measuring 17½in. long by 13¾in. wide, which was not strengthened as it should have been with a substantial mouthpiece, while the hole was laid lengthwise on the boiler, so that it had a very weakening effect. There was but one safety-valve, an inch and five-eighths in diameter loaded with a weight which at the end of the lever gave a pressure of about 150lb. per square inch, though it was stated that the boiler was ordinarily worked with the weight not at the end but mid-way. There was no steam pressure gauge and no glass water tube, the latter having been broken some weeks before the explosion and the boiler worked on without it, while there was no feed pump or injector for feeding the boiler, so that this could only be done by letting the pressure down, when the water was poured in through a pipe leading from two or three tubs placed 3 or 4ft. above the boiler.

When the boiler burst it gave way at the unguarded manhole just described, five rents starting from it, which ripped the shell completely open along the top from end to end. The explosion reduced the house to a heap of ruins, the brickwork and timber being scattered in every direction, and an adjoining street strewn with the *débris*, while other portions were thrown on to the roofs of neighbouring buildings. The manhole cover is reported to have been blown to a distance of 160ft., and the safety-valve 450, where it struck an adjacent chimney; while, in addition, the owners of the boiler, who were their own firemen, were both seriously injured, one of them fatally so.

From the evidence given at the inquest, it would appear that though the boiler was tended by its owners, this was done in a somewhat remarkable way. In consequence of there being no pump or injector, they were in the habit of charging the boiler with a whole day's supply at one time; and as the glass water tube was broken, they ascertained the amount of water in the boiler by tying an iron nut to the end of a string, and letting it down through the safety-valve, so as to take a sounding, stating, that after twelve hours' work they still found water in the boiler up to the tap at the bottom of the disabled glass water gauge. A mechanic, who had erected the engine and boiler, said, that when the steam got up to blowing-off point the owners were in the habit of drawing the weight to the end of the lever, in order to confine the steam in the boiler, instead of allowing it to blow off. Two engineers—one of whom made an official report on the cause of the explosion, at the order of the coroner—called attention to the weakening effect of the unguarded manhole on the boiler, the former stating, that if the boiler had been intended for high pressure, the manhole should have been strengthened, and the latter that he did not consider it safe at a higher pressure than 50lb. per square inch. Both of them concluded, after examining the plates, that they had not been overheated through shortness of water, while one of them added that the boiler was laid down, in the first instance, for a much lower pressure than that at which it had been worked, and to admit of an increase, the original safety-valve had been removed, and replaced by the one upon the boiler at the time of the explosion. The jury brought in a verdict 'That the explosion was due to shortness of water in the boiler, and the generation of gas which caused an over pressure;' while, at the same time, they censured the owner for not having supplied the boiler with a steam gauge and water gauge, expressing, in addition, their disapproval of the practice of placing such boilers in thickly populated parts of the town, and entrusting their management to incompetent men, to the imminent danger of the surrounding neighbourhood.

There appears to be an inveterate popular habit of attributing all explosions to shortness of water and the formation of gases, and it would have done more to prevent the recurrence of similar explosions if the jury, instead of launching into theory, had confined their attention exclusively to the practical defects in the equipment of the boiler—such as the absence of any feed pump, steam gauge, or glass water tube, the very disproportioned load upon the safety-valve, as well as the weakening effect of the large unguarded manhole—and pointed out the importance of having boilers more efficiently mounted. It appears that the joint of the manhole cover had been caulked with red lead but a few days prior to the explosion, and as the boiler burst the first time it was set to work after the caulking, it would seem as if the manhole then received its finishing touch, which is in accordance with the view previously expressed that the mischievous effect of these unguarded manholes is not due solely to the amount of metal cut away by the opening, but also to the strain put upon the plates in making the joint. It was not actually proved in the evidence that the weight was at the end of the safety-valve lever at the moment of explosion; even if it had been, and steam had been up to blowing-off point, viz., 150lb. on the square inch, it would not have led to the rupture of a shell of so small a diameter as this one was, had it been fairly made and suitably equipped; so that it would not appear correct to attribute the explosion simply to excessive pressure.

This explosion must, it is thought, be ranked among those due to defective boiler mountings, while it clearly affords an additional illustration of the danger of unguarded manholes, and the importance of having them all suitably strengthened with substantial mouth-pieces.

No. 29 Explosion occurred on Monday, June 11th, to a small boiler of the multitubular portable class, not under the inspection of this Association, and resulted in injury to two persons.

I have not had an opportunity of making a personal examination of the exploded boiler, but have been favoured with a photograph, as well as with particulars and sketches taken by an engineer on the spot, from which it appears that the primary rupture occurred at the crown of the outer casing of the firebox, the rent running in a longitudinal direction, and through the manhole, which was not strengthened with any mouth-piece.

The explosion is extremely similar to another which took place to a portable agricultural boiler when at work driving a threshing machine on the 9th of January, 1865, details of which were given in the report for that month, under the head of Explosion No. 3. Although there was no evidence in either of these cases of there having been excessive pressure, the question has been raised in both since the explosions occurred. Indeed in the first instance, an action to recover damages was brought by the owner of the boiler against the party to whom it had been let out on hire, on the assumption that the explosion was due to his having improperly screwed the safety-valve down. The desirability of avoiding this uncertainty, apart from considerations of safety, appears to me a sufficient reason for adopting the recommendation already given on previous occasions,* viz. that the spring balances with which the safety-valve levers of portable boilers are usually loaded should be fitted with suitable stop-collars or ferrules, which would render it impossible to screw the valves down beyond a predetermined pressure; added to which, all these boilers should have two safety-valves, one at least of which should be of dead-weight construction, and not placed inside the boiler where it would be out of sight, but outside, so as to be both above-board and accessible; while the constant recurrence of primary rents in boilers through unguarded manholes, of which the present explosion is an additional illustration, must be my apology for once more repeating the oft-reiterated recommendation, that all these manholes should be strengthened with substantial mouth-pieces.

Not one of the explosions given in the table occurred to boilers under the inspection of this Association. I have visited the scene of the catastrophe of the two that were most disastrous, viz., No. 46, which happened on December 25th, and resulted in the death of seven persons, as well as in injury to two

* See in The Artizan, Associations Monthly Reports. January, 1865. No. 3 Explosion. January, 1866, No. 6 Explosion. May, 1866, No 21 Explosion.

Tabular Statement of Explosions, from September 21st 1866, to October 26th, 1866, inclusive.

Progressive No. for 1866.	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
46	Sept. 25	Ordinary Single-flue or "Cornish." Internally-fired	7	2	9
47	Oct. 5	Portable Agricultural. Internally-fired	1	7	8
48	Oct. 8	Marine	2	2	4
49	Oct. 9	PortableVertical. Internally-fired	8	0	8
		Total..................	18	11	29

others; and also No. 49, which occurred on October 9th, and by which eight persons were killed. I am not able, however, on the present occasion, to give full details, but may briefly state that neither of these explosions arose from shortness of water or corroded plates. No. 46 was an ordinary Cornish boiler, 4ft. 6in. in diameter, and failed in the external shell at a brittle plate. The boiler in the case of No. 49 Explosion was a small vertical one, internally-fired, and most improperly equipped, having but a single safety-valve, whereas there should have been two; while the one with which the boiler was fitted was of a most dangerous construction. Also the manhole was not strengthened by any mouth-piece, and the boiler burst at that part. This is the second boiler of this class, and by the same maker, which has recently exploded with fatal results, so that it deserves serious attention. The details of both these explosions are important, and I hope to be able to give them at an early opportunity.

ROYAL GEOGRAPHICAL SOCIETY.

At the third meeting of the present Session of this Society, held on the 10th ult., J. Crawfurd, Esq., F.R.S., Vice-President, in the chair, a paper by Colonel C. W. Tremenheere, R.E., was the first read, "On the Physical Geography of the Lower Indus." The author described the plain of Sind, through which the Indus flows, and showed by the levels which had been taken that it formed a gradual slope towards the sea of 9·3 inches per mile, for a distance of 330 miles inland. Its soil was composed entirely of a very fine siliceous deposit mixed with clayey matter and mica; not a grain of sand could be found as large as a pin's head. The river in this distance has a length of 540 miles, and flows the whole length along a ridge, elevated above the plain. The solid matter annually brought down by its waters to the sea was calculated by the author to amount to 217¼ millions of cubic yards, which was sufficient to cover 70 square miles of the sea-bed with deposit one yard in thickness. Many details of the old channels of the river were given, and the course of the waters during seasons of inundation. The delta was also described, and the direction of the silt-bearing current out of the mouth of the Indus discussed in the paper. The author believed there was a shore-current flowing northwardly to the harbour of Kurrachee, and caused by the direction in which the waves during the south-west monsoon move towards the shore. It is precisely during the monsoon season that the Indus is discharging its heavily-laden flood-waters, and the result of the oblique action of the sea-stroke is not only to force matter held in suspension in the direction of the stroke, but to produce a shore-current. The opening of the Bay of Kurrachee, at the northern extremity of the delta, is in great part occupied by the island of Keamaree, and a great extent of mud banks, the superficial deposits of which are composed of matter identical with that found within the agoon of the delta, the sand of which Keameree is composed is also identical in composition with that carried to sea in the waters of the Indus. During the monsoon, however, there is a current in the offing setting to the south-east in a direction contrary to that of the coast-current.

Mr. W. P. Andrew adduced a number of facts to show that there were no signs of the harbour of Kurrachee having deteriorated since it has become used by us as a commercial port. So far from its being a decaying port, statistics proved quite the reverse; for, during ten years, its commerce has risen from £1,400,000 to upwards of £4,000,000, and the population of the town from 40,000 to 60,000. He believed that Col. Tremenheere was quite wrong in his inferences, on his own showing, for in an experiment which he tried with floating bottles, cast into the sea at the mouth of the Indus, although many were cast ashore northwards of that place, not a single one found its way to Kurrachee harbour; in fact, the current which brought them was met by another current, the existence of which could be proved, and so the bottles were carried away somewhere else.

Mr. Parkes (Engineer of the Harbour Works at Kurrachee) said that, until he had read the report of Col. Tremenheere, he had no suspicion of there being such a coast-current as that described by him, and he believed it was quite hypothetical; at any rate, there was no proof of its carrying silt into the harbour of Kurrachee, for a comparison of the recent official charts with the earliest one made (that of Captain Carliss, in 1838) showed that the harbour had become ather wider, and had certainly not deteriorated during the period in which we have data for the comparison. As to the waves during the monsoon striking obliquely on the coast, this was known to be quite erroneous; they strike at right angles to the coast, and the theory built upon that consequently falls to the ground. The speaker quoted official documents to show the vacillations of statement of Col. Tremenheere with regard to the currents.

Mr. J. Brunton, C.E., said the prevailing opinion amongst officers residing on the spot was that there was no current up the coast from the mouth of the Indus, but a current in the opposite direction. Kurrachee was wholly beyond the end of the Indus delta.

Captain Constable, of the late Indian Navy, the author of one of the official charts of the harbour, stated as the result of fifteen years' experience of the coast, that the harbour of Kurrachee was improving: there was evidently no silt carried into it. Col. Tremenheere was in error in assuming that the south-west monsoon was due south-west, striking obliquely on the coast; it was often westerly and north of west.

Captain Maury judged, from the analogy of the mouths of the Mississippi and the Amazons, and the absence of a delta projecting into the sea, that a current must exist at the mouth of the Indus; but he thought the facts laid before them showed that it did not sweep in the direction of the harbour of Kurrachee.

General Sir William Gordon spoke a few words in commendation of Colonel Tremenheere for excluding engineering topics from his paper; and the President, in concluding, remarked on the great and growing importance to India of such a harbour as Kurrachee. It was one of the four harbours only existing in the vast circuit of Hindostan, and he believed it was the safest and best, Bombay alone excepted.

A second was read, "On Lake Pangong in Western Tibet," by Capt. H. H. Godwin-Austen. In this paper the author gave an account of a journey he had made, whilst engaged in the operations of the Trigonometrical Survey, along the banks of this vast sheet of water, which, at an elevation of 14,000 feet above the sea, extends for a distance of about 100 miles in an elevated valley south-east of the Karakorum.

LONDON ASSOCIATION OF FOREMAN ENGINEERS.

The ordinary monthly meeting of members of this society took place in Doctors' Commons, City, on Saturday, the 1st of December. The attendance was very numerous and the chair was occupied by the president, Mr. Joseph Newton. The early part of the sitting was devoted to the election of new members, a consideration of the qualifications of candidates for association, and to a discussion of certain propositions of the chairman for extending the usefulness of the institution by means of a system of life assurance. When these matters had been satisfactorily disposed of, James Robertson, Esq., Iron Merchant, of Bankside, proceeded to read the fourth of his proposed series of six papers on the "History and Development of the Iron Trade." The author on this occasion confined his attention to the railway period, and traced with singular ability the progress of improvement in regard to the locomotive engine from the earliest dawning of the idea of that promoter of human comfort and convenience until the present time. As a matter of course Mr. Robertson travelled over ground which had been trodden before, but he succeeded in imparting to his subject fresh interest by his clever treatment of it.

The paper was listened to throughout with great satisfaction, and on its conclusion Mr. Robertson was much applauded. A discussion followed, and this was joined in by Messrs. Tomlinson, Stabler, Keyte, Barningham, Tijou, the Chairman and others. Finally a vote of thanks, proposed by Mr. G. Usher, and seconded by Mr. Keyte, was unanimously awarded to the author of the paper. Mr. Robertson in graceful terms acknowledged the compliments, and the proceedings of the evening came to a conclusion.

We understand that the annual meeting of the society is fixed for the fifth instant, and that then the election of officers for the year 1867 will take place. We trust that the accession of new members during the next twelve months will be as considerable as it has been in the last, and that in spite of the temporary depression of the engineering trade in the Metropolis the association may go on and prosper. The number of *bona fide* foremen connected with the society is exactly one hundred, whilst the honorary members, comprising engineers, employers, editors of scientific publications, and other gentlemen, swell the list to fifty more, in all one hundred and fifty. The funds in hand are gradually increasing, and there are few unemployed members to claim assistance from them.

HAYES CROSSLEY AND CO.'S IMPROVED PATENT NEEDLE.

This invention consists in forming what may be called double pointed needles, or, in other words, the needle is made to taper both to the point proper and to the opposite end in which the eye is made. Among other advantages this needle leaves the work freely and easily and is not in the least liable to catch or hold fast as is frequently the case with the ordinary sewing needle. We give an illustration representing one of these needles drawn to an enlarged scale with a view to show more clearly the nature of the improvement. From the point A to about the centre B, the needle is of the ordinary thickness, but from the part B the needle is tapered towards the head at C as shown on the illustration in place of being of the same diameter as the central part is in the

A B C

ordinary needles. This improvement entirely obviates the strain on the muscles of the fingers of the worker.

NEWCASTLE COAL.—RELATIVE PRICES OF COALS AT RATES PER IMPERIAL TON OF 20 CWT., AND PER NEWCASTLE (STANDARD) CHALDRON OF 53 CWT., IN SHILLINGS, PENCE, AND DECIMALS.

Newcastle Statute Coal Measure converted into the Equivalent Imperial Weight in Tons and Cwts.

Equivalent to			Equivalent to			Equivalent to		
Chldns.	Tons.	Cwt.	Chldns.	Tons.	Cwts.	Chldns.	Tons.	Cwts.
1	2	13	35	92	15	69	182	17
2	5	6	36	95	8	70	185	10
3	7	19	37	98	1	71	188	3
4	10	12	38	100	14	72	190	16
5	13	5	39	103	7	73	193	9
6	15	18	40	106	0	74	196	2
7	18	11	41	108	13	75	198	15
8	21	4	42	111	6	76	201	8
9	23	17	43	113	19	77	204	1
10	26	10	44	116	12	78	206	14
11	29	3	45	119	5	79	209	7
12	31	16	46	121	18	80	212	0
13	34	9	47	124	11	81	214	13
14	37	2	48	127	4	82	217	6
15	39	15	49	129	17	83	219	19
16	42	8	50	132	10	84	222	12
17	45	1	51	135	3	85	225	5
18	47	14	52	137	16	86	227	18
19	50	7	53	140	9	87	230	11
20	53	0	54	143	2	88	233	4
21	55	13	55	145	15	89	235	17
22	58	6	56	148	8	90	238	10
23	60	19	57	151	1	91	241	3
24	63	12	58	153	14	92	243	16
25	66	5	59	156	7	93	246	9
26	68	18	60	159	0	94	249	2
27	71	11	61	161	13	95	251	15
28	74	4	62	164	6	96	254	8
29	76	17	63	166	19	97	257	1
30	79	10	64	169	12	98	259	14
31	82	3	65	172	5	99	262	7
32	84	16	66	174	18	100	265	0
33	87	9	67	177	11	200	530	0
34	90	2	68	180	4	300	795	0

Relative Prices of Coals at Rates per Imperial Ton of 20 Cwt., and per Newcastle (Standard) Chaldron of 53 Cwt., in Shillings, Pence, and Decimals.

Equivalent to				Equivalent to				Equivalent to				Equivalent to			
Per Ton.		Per Newcastle Chaldron.		Per Ton.		Per Newcastle Chaldron.		Per Ton.		Per Newcastle Chaldron.		Per Ton.		Per Newcastle Chaldron.	
s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
1	0	2	7·8	4	9	12	7·05	8	6	22	6·3	12	3	32	5·55
1	3	3	3·75	5	0	13	3·0	8	9	23	2·25	12	6	33	1·5
1	6	3	11·7	5	3	13	10·95	9	0	23	10·2	12	9	33	9·45
1	9	4	7·65	5	6	14	6·9	9	3	24	6·15	13	0	34	5·4
2	0	5	3·6	5	9	15	2·85	9	6	25	2·1	13	3	35	1·35
2	3	5	11·55	6	0	15	10·8	9	9	25	10·05	13	6	35	9·3
2	6	6	7·5	6	3	16	6·75	10	0	26	6·0	13	9	36	5·25
2	9	7	3·45	6	6	17	2·7	10	3	27	1·95	14	0	37	1·2
3	0	7	11·4	6	9	17	10·65	10	6	27	9·9	14	3	37	9·15
3	3	8	7·35	7	0	18	6·6	10	9	28	5·85	14	6	38	5·1
3	6	9	3·3	7	3	19	2·55	11	0	29	1·8	14	9	39	1·05
3	9	9	11·25	7	6	19	10·5	11	3	29	9·75	15	0	39	9·0
4	0	10	7·2	7	9	20	6·45	11	6	30	5·7	15	3	40	4·95
4	3	11	3·15	8	0	21	2·4	11	9	31	1·65	15	6	41	0·9
4	6	11	11·1	8	3	21	10·35	12	0	31	9·6	15	9	41	8·85

THE CONVERSION OF THE NEWCASTLE COAL MEASURE INTO EQUIVALENT IMPERIAL WEIGHT, AND RELATIVE PRICES OF COALS.

FREQUENT inquiries having been made of us for data giving the relation existing between the Newcastle statute coal measure of chaldrons and the corresponding Imperial weight, we therefore re-publish tables, showing chaldrons converted into tons and cwts., and also the relative prices at per ton and chaldron respectively.

The merchants and other importers of coals abroad, and particularly engineers of steamers upon foreign stations, are often sorely puzzled to understand the nature of the differences existing between the mode of calculating quantities and values of coals and other commodities sold or shipped by local standards, and it is rightly considered to be a serious reflection upon us, as a great commercial nation (even as "a nation of shopkeepers"), that we have not adopted a uniform and well-understood system of weights and measures, and insisted on their exclusive use or employment, especially in our dealings with foreigners.

It is true that all coals are not sold by the Newcastle chaldron, nor are all Newcastle coals shipped abroad from the River Tyne bought by the chaldron or by the "keel," but this only serves to show the confusion that does exist in connection with the buying and selling of coals.

NEW EXPRESS ENGINE.

By Mr. J. C. CRAVEN, Loco. Supt. L. B. and S. C. Ry.

Illustrated by Plate 309.

In plate No. 309 we give longitudinal and cross sections of the express engine designed by Mr. Craven, of which we gave an outside elevation in THE ARTIZAN of January, 1865. The boiler of this engine is 11ft. 6in. long in the barrel, and 3ft. 10in. diameter, made of ½-inch plate, double rivetted in all seams, with a fire-box 4ft. 8½in. long by 4ft. 2¼in. wide measured over all; the inside fire-box is of copper, with wrought iron bottom ring, and clear water spaces tapering from 3ins. to 3¾ins.; the stays are made of copper screwed in the usual manner, and rivetted down both inside and outside, except in the lower part of the box, where they are provided with nuts inside; the roof stays are made of double bars 6in. by ⅝in. rivetted together, carefully bedded upon the end plates, and supporting the roof plate by means of bolts with nuts inside the box. The following are the particulars of the heating surface:—

153 tubes, 11ft. 9in. long × 2in. diameter	=	940 sq. ft.	
Fire-box „ „	=	91 „	
Total		1,031	
Grate area		14⅓ sq. ft.	

It will be observed that the orthodox proportion of *one* to *ten* in the ratio of direct heating surface to area of tubes is here carefully preserved.

The boiler is provided with three safety valves, of which two are placed upon the crown of the fire-box, and one on the top of the dome; and it is fed by two long-stroke pumps, and no injector is provided.

The valves are worked by shifting slot links suspended from their centres with the attachment of the eccentric rods behind,

The cylinders are 16½in. diam., with a stroke of piston of 22ins., transmitting its motion through a connecting-rod 7ft. long; the steam ports are 15ins. long × 1½in. wide, and the exhaust ports are 3½ins. wide.

The regulator is on the double-beat valve principle, with brass head and valve, and the steam-pipe is of copper, 5ins. bore.

The carriage consists of plate-iron inside and outside frames, the inside frame extending from the buffer-plank to the front of the fire-box, to which they are fixed by means of wrought-iron brackets, and the outside frame running from end to end of the engine, and provided with double horn plates rivetted to the main plate; the boiler is supported by the outside frames, at the fire-box end by means of forged brackets, and at the front of the engine by means of the smoke-box front plate; the draw plate is connected with the fire-box by means of longitudinal stretchers rivetted to the back plate of the box by means of angle iron. It rests upon three pairs of wheels, of which the leading and trailing ones are 4ft diameter, and the driving ones 6ft. 6ins., and all of which are provided with tyres of Burke's patent section; the leading and trailing axles are 6½ins. diameter, and have journals 9½ins. long × 5¼ diameter; the driving axle, which is also 6½ins. diameter in the body, is provided with inside. and outside bearings, the outside journals being 7ins. long × 5½ins. diameter; and the inside journals 5ins. long × 6½ins. diameter. The axle-boxes are all of cast-iron fitted with brass bearings, and the horn blocks are also of cast-iron rivetted to the frames.

The leading and trailing springs are 2ft. 11in. in length 7in. deep, in the centre and made of plates 4in. wide, the outside springs of the driving axle are 2ft. 9in. long 7in. deep in the centre, and the inside spring 2ft. 4in. long and 5in. deep, all made of 4in. plates and resting upon adjustable pillars.

The wheelbase is 16ft. namely: 8ft. between leading and driving wheels, and 8ft. between driving and trailing wheels. The weight of the engine in working order is 31 tons 12cwt., distributed as follows:—

Upon leading wheels.....................	10 tons 14cwt.
„ driving „	13 tons 10cwt.
„ trailing „	7 tons 8cwt.

The tender of which a diagram was given in The Artizan of January, 1865, has a capacity for 1,670 gallons of water and about 3 tons of coal; its weight in working order is 21 tons.

These engines run the express traffic between Hastings and London, of which the following are the particulars of a week's working:—

	Miles.	tons. cwt. coal.	lbs. per mile.
Engine No. 172,	524¼	9 7	39,89
„ 173,	813	12 14	34,99

The consumption of fuel appears rather high, but is accounted for by the fact that no allowance is made in the mileage, for shunting, forming trains, stoppage and lighting up.

THE INVENTION OF THE ELECTRIC TELEGRAPH.

Mr. Cromwell V. Varley writes to our contemporary *The Reader* upon the important subject of the invention of the electric telegraph. The following is an abstract of Mr. Varley's letter:—

As each property of electricity became known, its velocity being popularly considered instantaneous, it immediately suggested the idea of its application for rapid communication to a distance. Telegraphs were actually made and worked from one room to another, by means of static electricity, as far back as the last century, but the first person who proposed a telegraph worked by the voltaic battery, and who realised it, was Sœmmering. On the 6th of August, 1809, he constructed a telegraph, and exhibited it working through 2,000 feet of wire. This telegraph depended upon the decomposition of water by voltaic electricity. In the year 1802 Romagnosi discovered (and published the fact in Paris in 1804) that when a magnetised needle is submitted to the action of a galvanic current, it is deflected. In 1819 Oersted drew more particular attention to this fact, and from it resulted the galvanometer and the electro-magnet. It was Robert Norman, of the 16th century, to whom we owe the dipping needle, which gave rise to the vertical galvanometer or needle telegraph. The needle telegraph was the one first used in this country particularly. Electric telegraphs of different forms were proposed or invented by many. There were Alexander, Steinheil, Davy, and several others, all obtaining communication in different ways by means of voltaic electricity. Baron Schelling seems to have been the first to have constructed a submarine telegraph under the River Neva, at St. Petersburgh. It was he who constructed the first electro-magnetic telegraph, and in 1830 the Emperor of Russia saw it at work at Schelling's residence, when a distant mine was exploded by electricity before the Emperor. The same year Schelling started on a journey to China, and took his telegraph with him. He says he found it of great service to him, as it procured him introductions, and assisted him greatly in the object of his journey. To Sir William Watson is due the credit of having pointed out that the earth can be used to complete an electric circuit, and thus only one wire is necessary instead of two. It will, therefore, be seen that telegraphs were not only constructed, exhibited, and worked at a very early date by scientific men, but that Sœmmering had even proposed and exhibited his telegraph in 1809, which he described could be worked "by night as well as by day." In a word, the inventors of the electric telegraph are legion.

When in 1836 Mr. Cooke saw for the first time at Heidelberg a telegraph model at work, Baron Schelling's instrument, he immediately foresaw the great advantage to society that would result from its general introduction, and he set himself to work to realise this great idea. So diligently did he pursue his object that within twelve months he had invented a telegraph suitable for practical use. It was Mr. Cooke who first applied the attraction produced by voltaic electricity to the descent of a clock train, to control its motion or to ring a bell—an important step in practical telegraphy; and he at once entered into negotiations with the then Leeds and Manchester Railway for the construction of a telegraph on their line. After this he found many difficulties in his way the moment he had to telegraph through long distances, and immediately applied to the fountain-head for information, viz., to Professor Faraday. He was subsequently advised by Dr. Roget to consult Professor Wheatstone, an undoubtedly clever man, he having then in his possession at King's College a considerable length of insulated wire ready for experimental purposes. In 1837 Cooke and Wheatstone took out their first patent; and the electric telegraph shortly afterwards, thanks to Mr. Cooke's enthusiasm and energy, took root and spread over the length and breadth of the land. It was William Fothergill Cooke who went out on railway lines to combat the mechanical and other difficulties inseparable from all new works; he, who carried out the negotiations with the railway companies for the erection of the telegraphs on their lines; and it was he who proved to Robert Stephenson, Mr. Ricardo, and those gentlemen who formed the nucleus of the Electric Telegraph Company, that the electric telegraph was no chmera, but a really soundi, practical, commercial undertaking. So successful was he that eight years did not elapse before there were telegraph circuits ninety miles in length at work between Gosport and London.

No one will, I hope, for a moment doubt that Professor Wheatstone was a most active and useful scientific adviser to and co-operator with Mr. Cooke, and that a very great amount of credit is due to him; but when we consider the question as to whom Europe is indebted to for the introduction of the telegraph as a great commercial undertaking, then the credit must undoubtedly belong to Mr. W. F. Cooke, for had he not happily been introduced to Professor Wheatstone his energy and enthusiasm were such that the telegraph would still have been a *fait accompli*, though probably not perfected so soon, for he would have sought other scientific aid to help him to combat the difficulties which presented themselves. * * *

STATISTICAL SOCIETY.

RAILWAY EXTENSION AND ITS RESULTS.

Read by R. Dudley Baxter, M.A.

(*Continued from ser. iii., vol. iv., page 248.*)

The following are further extracts from Mr. Baxter's paper, the first portion of which appeared in The Artizan of December, 1866:—

VI.—*Railways in France.*

In turning from England to France, we enter a country completely different in its railway organisation. In England everything is left to individual enterprise and independent companies. In France nothing can be done without the aid of the Government. They tried the English system, and failed, just as they tried Parliamentary government and failed. The independent railway companies broke down, and it was found absolutely necessary to change to a *régime* of government guarantees and Government surveillance, suited to the genius of the French people, and under which they regained confidence and prosperity. The success of the Manchester and Liverpool Railway provoked some real though short railways in France, especially those from Paris to St. Ger-

main and to Versailles. But in 1837 only 85 miles had been opened, against nearly 500 in England. In 1837 and 1838 the French Chambers threw out a scheme of their Government for the construction by the State of an extensive system of railways, but granted concessions to private companies for lines to Rouen, Havre, Dieppe, Orleans, and Dunkirk. These lines were abandoned for a time in 1839, from want of funds. In this emergency, Mr. Locke, the great English engineer, restored the fortunes of French railways. Assisted by the London and South-Western Company and Mr. Brassey, and with subventions from the French Government, and subscriptions from English shareholders, and a powerful corps of English navvies, he commenced, and carried through the line from Paris to Rouen, and from Rouen and to Havre, and fairly gave the start to railway enterprise in France. In 1842 a new law was passed, by which the State undertook the earthworks, masonry, and stations, and one-third of the price of land; the departments were bound to pay by instalments the remaining two-thirds of the land; and the companies had only to lay down rails, maintain the permanent way, and find and work the rolling stock. It was intended that three-fifths of the total cost should be borne by the State and departments and two-fifths by the companies. Under this system of subventions a number of concessions were made, the shares rose to 50 per cent. premium, and in 1848 a total of 1,092 miles had been opened. The revolution of 1848 was a terrible shock to their credit, and shares went down to half their value. Many lines became bankrupt and were sequestrated, and for three years fresh concessions were entirely dropped. But the concessions already made were slowly completed, and by the end of 1851 France had opened 2,124 miles, against 6,889 opened in the United Kingdom. In 1852 the Emperor took French railways in hand, and by a system of great wisdom, singularly adapted to the French people, he put an end to the previously feeble management, and launched into a bold course of railway development. The French public shrank from shares without a guarantee; he gave a State guarantee of four or five per cent. interest. The French public preferred debentures to shares; he authorised an enormous issue of debentures. The companies complained of the shortness of their concessions; he prolonged them to a uniform period of ninety-nine years. At the same time he provided for the interests of the State by a rigid system of government regulation and audit. And, lastly, coming to the conclusion that small companies were weak and useless, he amalgamated them into six great companies, each with a large and distinct territory, and able, by their magnitude, to inspire confidence in the public, and aid the Government in the construction of fresh railways. This vigorous policy was very soon successful. Capital flowed in readily, construction proceeded with rapidity, and between the end of 1851 and 1857 the length of the railways opened was increased from 2,124 to 4,475 miles, or more than doubled. England at that time had opened 9,037 miles. France was now exceedingly prosperous. Her exports and imports had increased from £102,000,000 in 1850 to £213,000,000 in 1857, or more than 100 per cent. in seven years. The six great companies were paying dividends which averaged ten per cent., and the government guarantee had never been needed. Railways united all the great towns and ports, and met the most pressing commercial wants. But the Emperor was not satisfied. France, with double the territory of England, had only half the railway accommodation, and wide districts between all the trunk lines were totally unprovided with railways. The Government engineers of the *ponts et chaussées* were prepared with plans and estimates for 5,000 miles of lines, which had been inquired into, and officially declared to be *d'utilité publique, i.e.,* a public necessity. The country districts clamoured for these lines; but how were they to be made? The public were not prepared to subscribe for them, the government would not undertake them, and the great companies were too well satisfied with their ten per cent. dividend to wish to endanger it by unremunerative branches. The plan of the emperor was intricate, but masterly. He said to the companies, "You must make these lines. The 4,525 miles of railway already made shall be a separate system for the present, under the name of *Ancien Reseau*, the old lines. You no longer require the guarantee of the State for these lines, but I will give you an extension of the ninety-nine years of your concessions, by allowing them to commence at later dates, beginning with 1852 for the Northern Company, and at various dates for the rest, up to 1862, for the Southern Company. I also engage that £9,000,000 sterling of the net revenue of these old lines shall for ever be divisible among the shareholders, without being liable for any deficit of the extension lines, an amount which will give you a clear and undefeasible dividend of six to eight per cent, with strong probability, almost a certainty, of getting much more from surplus traffic. Next, the new lines, 5,128 miles in length, shall be a separate system, under the name of *Nouveau Reseau*, or extension lines. Their estimated cost is £124,000,000, and you, the companies, may raise the sum by debentures, on which the Government will guarantee four per cent. interest, and 65 sinking fund for paying them off in fifty years. Any extra cost you must pay yourselves." These, in their briefest possible form, are the terms on which the Emperor imposed an average of nearly 1,000 miles per company on the six great companies of France. They were accepted with considerable reluctance. Their effect has been to lower the value of the shares of the great companies, for the bargain is considered disadvantageous. The companies cannot borrow at less than 5·75, so losing 1·10 per cent. per annum on every debenture; and as the lines cost more than the £124,000,000, the overplus has been raised by the companies by debentures, for which they alone are responsible. But, on the other hand, they get an immense amount of fresh traffic over their old lines, which must ultimately more than repay this loss. English railways would be thankful if their extensions cost them so little. In the following years other lines were added, with similar guarantees and with considerable subventions from the State, and in 1863 an additional series of lines, 1,974 miles in length, were imposed on similar terms, but with some modifications of the conventions with two of the weakest companies. Besides these government lines, the Emperor encouraged to the utmost the efforts of the departments, and in July, 1865, a law was passed respecting *chemins de fer d'interêt local,* which authorised departments and communes to undertake the construction of local railways at their own expense, or to aid concessionnaires with subventions to the extent of one-fourth, one-third, or in some cases one-half the expense, not exceeding £240,000. Not content with passing this law, the minister of public works, in the very next month, wrote to the prefects of the eighty-eight departments of France, to acquaint them fully with its provisions, and to invite them to communicate with their councils general, and deliberate upon the subject. The result was that sixteen councils requested their prefects to make surveys and inquiries to ascertain what lines would be advisable. Thirty-two departments authorised their prefects to prepare special plans, and even to make provisional agreements with the companies to carry out lines, subject to confirmation by the councils. Two of these made immediate votes, viz., the department of Ain, £56,000, and Herault, £260,000, for lines which they approved. A third, the department of Calvados, voted subventions amounting to £1,000 per mile for one line and £2,000 per mile for another line. Besides, these five departments put railroads into immediate execution by contracts with independent companies.

	Subvention.
Saône et Loire	£14,000
„ (besides the land)	40,000
Manche (with an English Company, and including land)	40,000
Rhône	240,000
Tarn	171,000

By these measures the Emperor has brought up the concessions to the following total:—

	Miles.
Ancien Reseau, or old lines	5,027
Nouveau „ or extension lines	7,565
	12,592
Being very nearly the length of our constructed lines in 1864. But of this mileage there has been constructed up to the present time only	8,134
Leaving still unconstructed	4,458

being one-third of the whole concessions. Of this 1,800 miles are now being constructed, and 1,600 miles are expected to be opened by the end of 1867. Hence the lines constructed in France up to and including 1865 are 8,134 miles, or about the same length as the lines constructed in the United Kingdom to the end of 1855; so that France is ten years behind England in actual length of railways constructed, and at least fifteen years behind England, if her larger territory and population are taken into account; and I must add that France would have been very much farther behind, had it not been for the vigorous impulse and the wise measures of the Emperor Napoleon. The progress of completion from 1837 to the present time is shown in the following table:—

Miles constructed.

Year.	Miles open.	Annual Increase Miles Average.
1837	85	
		84
1840	338	
		34
1845	508	
		259
1850	1087	
		301
1855	3315	
		454
1860	5586	
		509
1865	8134	

This table shows the insignificant rate of progress up to 1845, and the larger but still slow progress up to 1855. From that time the effect of the Emperor's policy becomes visible in the increased rate of progression. It is expected that between 1852 and 1872 more than 9,500 miles will have been opened, quadrupling the number constructed in the previous 20 years, and contributing in the highest degree to the prosperity and wealth of the French nation. Railway history in France may be briefly summed up in four periods :—1. The period of independent companies from 1831 to 1841. 2. The period of joint partnership of the State and the companies from 1842 to 1851. 3. The period of Imperial amalgamations and guarantees from 1852 to 1857. 4. The period of guaranteed extension lines from 1858 to the present time. The capital authorised and expended to the 31st December, 1865, was as follows :—

Capital authorised.

Ancien Reseau, or old lines	£151,000,000
Nouveau „ or extension lines	209,000,000
	£360,000,000

Including £64,000,000 subventions.

Capital expended, 1865.

Debentures	£178,700,000
Shares	54,800,000
Subventions	27,500,000
	£261,000,000

So that the French companies borrow more than three times the amount of their share capital, reversing the English rule, of borrowing only one-third of the share capital. But if we consider preference capital as a second mortgage, the English practice is to borrow an amount equal to the ordinary share capital. This, however, is still a long way from the French regulations. The capital not paid up is nearly £100,000,000. Of this nearly one-half will be required in the next three years for lines approaching completion. The cost per mile of French railways is as follows:

Ancien Reseau	£30,650
Nouveau	27,350

As the *nouveau reseau* is almost entirely composed of single lines, this does not show very great cheapness of construction. We are making our country lines much cheaper, particularly in Ireland and Scotland. The effect of railway competition with canals was the same as in England. The canal rates were reduced to one-third of their former amount, and the canal traffic has increased instead of diminishing. The average railway fares and rates are stated by M. Flachat, in his work on railways, to be 6 to 7 centimes for each passenger, and 1 sou per kilometre, being 1d. to 1-$\frac{1}{10}$d. per mile, as compared with $1\frac{1}{3}$d. per mile, the average on English railways. The increase of traffic since 1850 is stated in the official returns as follows :—

Increase of Traffic.

Year.	Total. Receipts. £	Average Annual Increase. £	Average Annual Increase for 15 years. £
1850	3,824,000		
		1,307,000	
1855	10,358,000		
		1,217,000	1,238,400
1860	16,443,000		
		1,192,000	
1865	22,400,000		

Thus the increase has been more equable than in England, but smaller in amount, showing an average of £1,238,400, against £1,423,000 in England. The effect of railways on the condition of the working classes has also been very beneficial. The extreme lowness of fares enables them to travel cheaply, and the opportunity is largely used. The number of third class passengers in France is 75 per cent. of the total passengers, against only 58 per cent. in England (M. Flachat, p. 60).

Average receipts and dividends per cent.

The gross traffic receipts of French lines are 9·6 per cent. on the share and debenture capital, or 1 per cent. more than in England, and the net receipts (after deducting 45 per cent. working expenses)is now 5·28 per cent. on the total debenture and share capital, being ·82 or about four-fifths per cent. bigher than in England. Yet the French Companies pay an average dividend of 10 per cent., while the English pay a dividend of only $4\frac{1}{2}$ per cent. Here are the figures, for the benefit of the sceptical :—

	1859.	1861.	1865.
Gross receipts	10·5	11·0	9·6
Net receipts	5·7	6·2	5·28
Dividends of great companies—			
Nord	15	16·5	17·87
Orleans	18	20	11·2
Midi	4	10	8
Ouest	7·5	8·5	7·5
Est	8·13	8	6·6
Mediterranée	10·6	15	12
Average	10·54	13	10·53

Look at the table of capital expended. Disregarding the £27,500,000 subventions as corresponding to the *dixième* tax paid by the companies, there is £233,000,000 of share and debenture capital, out of which a portion of the debentures are charged to capital under the conventions for the extension lines, being for new companies that have not yet been transferred to the revenue account. Hence the interest-paying capital is reduced and the interest itself increased. But this is not enough. In 1863 the State bound itself to contribute to certain lines annual subventions which, in 1865, came to £551,000, and the State also paid during the same year in respect of their guarantees of the debentures in the *nouveau reseau* £1,320,000, making a total subvention in 1865 of £1,871.000, an amount sufficient to pay more than 3 per cent. on the share capital of £54,800,000. The guarantee of £1,320,000 on the *nouveau reseau*, however, is not an absolute subvention, as it will be repayable gradually by the companies when their income exceeds a fixed amount. It is therefore a loan by the State, repayable on the occurrence of a contingency and at an uncertain date. In England it would never be borne for an instant that six great companies, say the London and North Western, Great Western, Midland, and others should receive 10 per cent. dividend, and yet pay no interest on £27,000,000 of public money invested in their lines. Still less would it be borne that, beyond this large subvention and dividend, they should receive from the State annual subventions and guarantees amounting to £1,800,000.

One characteristic of the French system is the absence of competition, and this is opposed to all ideas of freedom of communication. The Northern Company monopolises the whole traffic between Calais and Paris. The Mediterranean Company monopolises the whole traffic between Paris and Marseilles, a traffic of extraordinary importance and value. An attempt made two years ago by another company to obtain an extension to Marseilles, and to establish an alternative route, was rejected by a Government commission after a very long inquiry. The consequence of this system is a great concentration of traffic in a small number of trains, to the profit of the Companies and to the inconvenience of the traveller. There are in England, between places like Liverpool and London, about three times as many trains as there are in France between Marseilles and Paris. And besides this, goods are sent less rapidly in France, and delivered with less punctuality. But there is a great deal to be said in defence of the French system. It avoids the duplicate lines necessary for competition, which France could not well afford. It keeps the companies prosperous and able to aid the Government in railway extension. It is not an irresponsible monopoly, able to charge high prices to its customers, but a strictly regulated monopoly, with its tariff fixed by government at the lowest prices that will be remunerative. I should add that there is a continuous audit of the accounts of the companies by government accountants, who attend from week to week at the companies' offices for that purpose. I will at present mention only one other point in French railway law, that the government has the power of purchasing any line of railway after fifteen years from its first concession. The price is to be fixed by taking the amount of the net profits of the seven preceding years, deducting the two lowest years, and striking the average of the remaining five years. The government is then to pay to the company for the remainder of the concession an annual rent-charge or annuity equal to the average so determined, but not less than the profits of the last of the seven years. This mode of purchase appears preferable to the English law, since it does not require the creation of any new rentes or consols; and I commend it to the notice of Mr. Galt.

I have mentioned these prominent features of the French law, in the hope that they may be useful in suggesting improvements in the English system. Why should we not vest in the president of the Board of Trade a power of making and enforcing regulations for the public safety and convenience? Why should we not introduce more frequent railway commissions to consider important questions, and recommend to the president of the Board of Trade or to Parliament? Why should we not have a modified system of audit, and a registration of shares and debentures?

TELEGRAPH MANAGEMENT.

A scheme has been drawn up by Mr. Scudamore, of the General Post Office, for transferring the working of the telegraph from private companies to the Government, in conformity with the system in universal practice on the continent. The framer of the scheme proposes that all the telegraph lines of the United Kingdom should be purchased by the Government and worked on the same plan of centralisation as the Post Office. In the opinion of the proposer, a vast benefit will accrue to the public from the realisation of his project, as the reduction of the working expenses and the thorough uniformity in the organisation of the service will enable a large reduction of the present tariff to be carried out immediately on the Government taking possession of the lines. It is to be remarked that in Switzerland, where an uniform charge of 1 franc per telegram has long been in use, the financial condition of the lines is highly satisfactory, whilst correspondence by telegraph is within easy reach of all purses. In this respect, France, Germany, and Belgium are also far ahead of Great Britain. It is reported that Mr. Scudamore's scheme was countenanced by Lord Stanley the late Postmaster-General, and meets likewise with the approval of the present Government.

THE PORT OF GEESTEMUENDE.

Some ten years ago the Prussian Government purchased from that of Oldenburg two slices of territory adjoining the bay formed by the mouth of the small river Jahde, for the purpose of erecting a naval port and dockyards, no other portion of the shore of the German ocean being then in Prussian hands. These endeavours have, however, been baffled, hitherto, by the sands, which cannot, at this particular place, be prevented from continually choking up the harbour, and thus rendering useless the works for which several millions of thalers have already been expended. Prussia having, by the annexation of the kingdom of Hanover, come into possession of the mouths of the rivers Elbe, Weser, and Ems, three of the main arteries of Germany, and acquired the ports of Emden, Harburg, and Geestemuende, the government of that country has now decided that at the latter port a royal naval station should be established. However, the harbour of Gestemuende is to remain open to the commercial and shipping traffic, as heretofore, and its importance is to be enhanced by further improvements. Some particulars respecting this harbour, which we extract from *Mitchell's Steam Shipping Journal*, may be interesting to most of our readers:—

The new harbour of Geestemuende was opened in July, 1863, and, notwithstanding its admirable position for trade and its other advantages, has not yet been used commercially to any great extent. Its neighbours, Bremen and Hamburg, have monopolised the shipping business of Germany, though Geestemuende has secured to itself the petroleum trade of the Weser, and it seems possible that the wood trade will also follow, as the facilities for wood stacking are far superior to those of Bremen. The Hanoverian Government constructed the embankments, and shelter for shipping, in consequence of the importations and exportations of the kingdom finding their inlet and outlet through the Elbe and Weser—which rivers flow through Hanoverian territory—at the ports of Hamburg and Bremerhaven, which latter had become so well known, and the merchants established there so rich and influential, that nothing short of a more secure port would be likely to tempt shippers to make a change. The harbour is well protected from the wind, and is open when the Elbe and Ems are closed to shipping by the ice. This arises from a low temperature which accompanies the east wind, and the ice being driven from the shore along the site of the harbour. The large harbour or basin is 1,734ft. in length and 400ft. in breadth. The depth of water on the eastern side is 25ft., and on the western side 21ft. The lock has a clear breadth of 76 2-3ft., and the chamber a length of 239 2-3ft. The sluice entrance to the basin has flood and ebb gates, so that ships can run in and out at almost any time of the day or night, and are not restricted to a short time before or after high water. Ships of 220ft. in length can use the sluice as a chamber-lock, while vessels of greater length can pass in and out at high water, while the flood-gates are open. The warehouses are very extensive, and connected with the railway system of the whole of Germany. The rails are on a level with the quays and canals, and brought so close to the water that the shipment of goods can be effected direct from the trucks to the vessels. There is likewise a branch line of railway from Geestemunde to the docks at Bremerhaven. These works cost the State of Hanover in all 5,800,000 thalers, but with this large outlay they are of too recent a date to have yet produced an equivalent return. Before the war between Prussia and Austria, the port was used by the latter power as a station for the North Sea squadron, the frigates *Kaiser, Max*, and *Friedrich*, having laid there for a considerable time. The Hanoverian Government were desirous to establish regular lines of steamers between Geestemunde and England, but the efforts in this direction failed from those undertaking the service not receiving a subsidy. It was thought, at one time, that transatlantic steamships would be placed on for New York, but so far the capital has not been forthcoming to provide a fleet of suitable vessels for the purpose. The emigration from Bremen during thirty years—from 1832 to 1862—was 793,267 persons, being an average of 25,589 per annum. A considerable proportion of these emigrants were from Hannover and the Rhine provinces. It was, therefore, natural to expect that Geestemuende would be favoured with a large share in this trade, if first-class steamers were to run to America. From Hamburg the emigration in 1860 was 13,012; in 1861 it increased to 14,649, in 1862 to 19,883, in 1863 to 21,886, but fell in 1864 from exceptional causes to 19,747. In 1865 it is shown by official returns that there sailed from Hamburg, in 94 vessels, no less than 36,878 emigrants, and from Bremen 44,181 in 128 vessels. Before steamers sailed from Hamburg and Bremen there was a great falling-off in the emigration from Germany, but during the last few years it has risen again, and there is evidence of an augmentation from several of the provinces. A line of English branch steamers to Geestemuende might divert a portion of this stream through British ports. Corn and cattle are being raised in greater quantities than formerly throughout Hanover, in view of an export trade, chiefly to this country, and Geestemuende would appear to be admirably situated for such a traffic. Under Prussian administration we may expect to see an improvement in the commerce of the port, if the harbour is not impeded by ships of war.

NAVAL ENGINEERING NOTES.

THE "UNION."

The steamer *Union*, built and engined for the North German Lloyd, of Bremen, by Messrs. Caird and Co., Greenock, went down the Clyde last month, and made a satisfactory trial trip. The dimensions of the *Union* are:—Length of keel and fore rake, 325ft.; breadth of beam, 40ft.; depth from floor to upper deck, 33ft. 6in. She has four decks, and is brig-rigged. The *Union* is propelled by direct-acting inverted cylinder engines of 500 horse-power nominal, having one of Krupp's cast steel crank shafts and is fitted with surface condensers, superheating apparatus, and other recent improvements.

THE HANCOCK PROPELLER.

A trial of a new screw-propeller, patented by Messrs. F. and C. Hancock, Dudley, has been made at Portsmouth, with No. 25 steam launch, the vessel being fitted with twin-screw engines by Messrs. J. Penn and Son. The weather was unusually rough for such a trial, but it was nevertheless made, and the customary six runs taken with and against the tide, over the measured mile in Stokes Bay, as follows:—First run, 6·451 knots; second run, 7·894 knots; third run, 6·383 knots; fourth run, 8·019 knots; fifth run, 6·164 knots; sixth run, 8·090 knots. Mean speed of the launch, 7·1 knots. The new screw is two-bladed, each blade being without any curve, the external circumference forming the fourth part of an oval. The launch drew 2ft. 10in. of water forward, and 3ft. aft. The steam pressure in the boilers was 70lb., and the revolutions of the engines continued steadily throughout at 324. There was no vibration.

ANCHORS AND CABLES.

The new law on the merchant navy of France, permitting the free import of all objects, raw or manufactured, employed in the building, rigging, fitting out, or repairing of sea-going vessels destined for commerce, having been promulgated on the 12th of June last, we might have expected before this there would have been an increase in the quantity of anchors and chain cables imported into that country. But, on the contrary, there has been a decline. The quantity introduced in the ten months of this year was, 58 tons of anchors of $\frac{1}{4}$ ton weight and under, 220 tons of more than $\frac{1}{4}$ ton, and 87 tons of chain and chain cable; whereas in the corresponding period of last year the quantities were 61,290, and 98 tons; and in 1864, 27,274, and 99. The decline can only be owing to the depression in commerce caused by the war between Austria and Prussia.

THE LARGEST SHIP YET CONSTRUCTED IN AMERICA.

The following are the measurements of the *Great Republic*, the largest ship yet constructed in America:—The first of the new steamers now building for the Pacific Mail Company's line between San Francisco and China, recently launched from the shipyard of Mr. Henry Steers, at Greenpoint, New York. Length extreme 380ft, length between perpendiculars 360ft., width of beams moulded 48ft. 6in., width of beam extreme 50ft., depth of hold 31ft. 6in. The *Great Republic* is believed to be the strongest ship afloat; her frame timbers are of white and live oak, these are fastened with copper and iron, and braced with straps of iron 5in. wide and $\frac{7}{8}$in. thick, crossing each other diagonally every 4ft.; over this comes the inner planking caulked and payed with pitch, and then double strapped as before, and outside this double strapping comes an exterior of double planking of Georgia yellow pine. She has three decks, unusually stout and strongly fastened, and four water-tight bulkheads. Her

engines are vertical beam, having a single cylinder of nearly 9ft. in diameter and 12ft. stroke. The paddle-wheels are to be 40ft. in diameter, having a face of 12ft., and each wheel is provided with thirty-four oak buckets or floats. The *Great Republic's* registered tonnage is 4,100, 5,200 builder's measurement, exclusive of engine-rooms.

THE ROYAL ARSENAL, WOOLWICH.

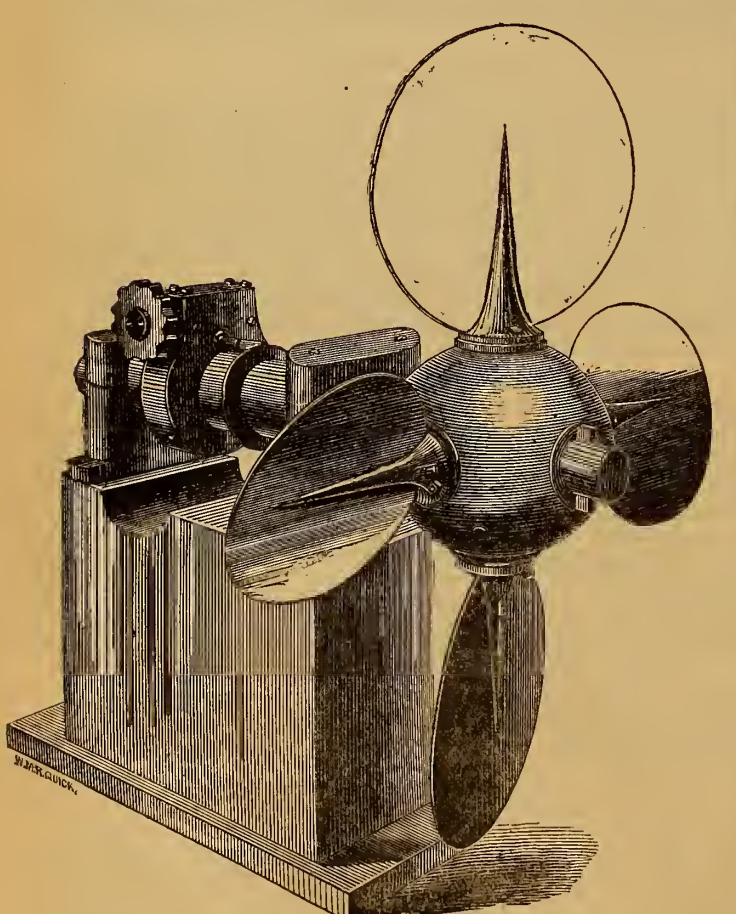
Upon the resumption of work in the various departments here on Thursday last, after the holidays of Christmas and Boxing-days, much activity was evident in the laboratory and gun-carriage departments, the gun-carriages, slides, and platforms required by the Admiralty, in accordance with a recent order, giving increased work to the latter department. A considerable number have already been forwarded to various ports, and we understand that some of the most experienced and meritorious workmen are to receive a week's extra pay as exertion money. We hail with much pleasure this judicious step on the part of the authorities, an example which might be followed with advantage in many cases by private employers.

Most of the specimens of guns, carriages, &c., to be forwarded to the Paris exhibition have been prepared ready for transit by means of steam vessels.

FEATHERING SCREW PROPELLER.

We give an illustration of a Feathering Screw Propeller, taken from a very beautifully-executed model recently exhibited at the Agricultural Hall, Islington.

This screw is totally different to any yet introduced, and the inventor alleges that, besides surmounting the many and serious drawbacks with which screw-propellers in present use are fraught, it secures advantages of the most important and paramount character. It is constructed on sound mechanical principles, combining strength and simplicity, and was awarded by the Royal Cornwall Polytechnic Society a first-class silver medal, accompanied with a very high eulogium.



It will be seen from the illustration that the blades are *flat* and *circular*. In these respects the inventor has wholly departed from the long-cherished principle, namely, that of imparting a *curve* to the blade, and substituting in lieu of the numerous distorted forms now in use *round* or *circular* blades, which have the advantage of securing a large surface, and throwing off everything they might come in contact with.

It will be further seen, on reference to the illustration, that the blades are kept clear of the boss. The object of so doing is to allow a free passage for the water at this point, the inventor alleges that he has found from numerous experiments that it is a great mistake to encircle the boss with the blades the tendency being to lock the water, thereby retarding the vessel's progress. The following are stated to be the advantages this invention possesses:—1. The fans or blades are susceptible of being set at any angle, from one to ninety degrees, which is accomplished from *within* the vessel. 2. A vessel fitted with a screw on this principle would be strictly a sailing ship when proceeding under canvas alone, the blades or fans can be set in a neutral position, *i.e.*, in a line with the ship's keel, consequently not the slightest obstruction would be offered to the vessel's progress. 3. A disabled or broken blade can be removed, and a perfect blade inserted in the boss, without removing the screw or placing the vessel in dock, thereby saving considerable expense and time. 4. It dispenses with the complicated and expensive machinery for lifting the screw out of the water when the vessel is under canvas, also the objectionable well or chamber for receiving the screw when not in use. 5. The pitch can be altered in a few minutes to suit the vessel's trim in any and every state of the weather. 6. As an auxiliary it stands unrivalled, being a great economiser of fuel and time, which are of infinite value to shipowners. 7. A ten-ton screw can be set at any angle by one man; and a self-registering index records the various angles, by which the engineer can detect the pitch of the screw. 8. It further possesses a most invaluable feature, viz., its non-liability to foul, it being so constructed that everything coming in contact would be thrown off, whilst the tendency of the screw in present use is to harbour and embrace everything it comes in contact with. The *Royal Charter* and several other large ships were disturbed by the fouling of the screw.

We have thought it but fair to the inventor, who has expended much time and money in experimenting on screw propulsion, to give his own views as to the merits of his screw.

THE ARCHITECTURAL MUSEUM.

The Council of the Architectural Museum have secured a site for the Museum, which it is anticipated will prove fully adequate for the purpose and conveniently situated. The spot selected is a plot of ground, within two minutes' walk of Westminster Abbey and the Palace of Westminster, and approached from Great Smith-street. This does not indeed pretend to be a fashionable neighbourhood, but the Council flatters itself that its retirement will be accepted as one of its merits, situated, as it is, in immediate proximity to a quarter of London extensively inhabited and used by art-workmen. The dimensions of the plot of ground are upwards 5,000 superficial feet, and it is held on very liberal conditions.

Money will, however, be required for the erection of a plain building, of which Mr. J. Clarke and Mr. Ewan Christian have kindly undertaken to act as honorary architects, and for this purpose (liberally aided though it will be by the Department of Science and Art in the removal and re-arrangements of the collection), the Council of the Architectural Museum would desire to raise a sum of £2,000. Various members of its body have we understand, voluntarily promised £10, and the Council feels that it is justified in asking for a like sum from others of its friends (payable by two instalments, if preferred), while at the same time subscriptions to any amount will be gladly received. Payments may be made to the treasurer, G. G. Scott, Esq., R.A., 20, Spring Gardens, London, S.W.; to the hon. secretary, Joseph Clarke, Esq., F.S.A., 13, Stratford-place, London, W.; or to the Architectural Museum Building Fund Account, at Messrs. Cocks, Biddulph and Co.'s Bank, 43, Charing-cross, London, S.W.

We wish this very desirable undertaking every possible success.

ANTI-ATTRITION POWDER.—Under this heading the Patent Plumbago Crucible Company, of Battersea, have recently introduced an impalpable powder, perfectly free from grit, which has the property of cleansing and polishing the machinery to which it is applied. It is found to answer admirably the purposes for which it is intended, and is coming largely into use, we understand, for lubricating the cylinders of blowing engines, and for dusting moulds for iron and brass castings, as well as the ingot moulds for Bessemer steel. This anti-attrition powder does not heat, and possesses the great advantage of not catching dust, &c., as oil and grease do. It is found that it adheres well to metals, and it is thus particularly applicable to quick-running shafts, as it does not fly off.

THE COMPOSITION, VALUE, AND UTILISATION OF TOWN SEWAGE.

(*Continued from page* 278.)

The chemical examination of the grass grown at Rugby showed that at the stage of growth at which it was cut the sewaged grass contained a less proportion of dry or solid substance than the unsewaged; that the grass cut during the later portions of the season, both unsewaged and sewaged, contained less solid matter than that cut during the more genial periods of growth; that the proportion of nitrogenous substance, and also of impure fatty or waxy matter, was much greater in the solid matter of the sewaged than in that of the unsewaged grass; that the proportion of nitrogenous substance was also much higher in the solid matter of the grass grown towards the end than earlier in the season; that the proportion of idigestible woody-fibre was much about the same in the dry substance of the unsewaged and of the sewaged grass, but progressively diminished as the season advanced; and, lastly, that a given amount of the dry substance of grass grown in a cold and wet season, or during the cold wet periods of the year, generally contained more nitrogenous substance than that of grass grown in more genial weather.

It will be seen presently, that, with these differences in botanical and chemical character between the unsewaged and the sewaged grass, when used as food, a given quantity of the fresh unsewaged grass, was more productive of both meat and milk than an equal weight of the fresh sewaged grass; but a given weight of the dry or solid substance of the sewaged grass was more productive than an equal weight of that of the unsewaged. Further, the less nitrogenous grass of the more genial periods of the season was more productive than the more highly nitrogenous produce of the less genial points.

Experiments were made at Rugby with Italian rye-grass as well as meadow-grass, but the results were not sufficiently distinct in their character from those above described to render it of much interest to consider them in this place.

The next points to consider are—the comparative food-qualities of unsewaged grass, and the best or most profitable mode of utilising sewage-irrigated grass.

When in the experiments at Rugby the grass was cut green and given to fattening oxen tied up under cover, more of the sewaged than of the unsewaged, reckoned in the fresh or green state, was both consumed by a given weight of animal within a given time, and required to produce a given weight of increase; but of real dry or solid substance, less of that of the sewaged than of the unsewaged grass was required to produce a given effect. When the grass was given alone the result was very unsatisfactory, but when oilcake was given in addition, the amount of increase upon a given weight of animal within a given time, and for a given amount of dry substance of food consumed, was not far short of the average result obtained when oxen are fed under cover on a good mixed diet. Still, the pecuniary result with the oxen, whether reckoned per acre or for a given amount of sewage, was by no means satisfactory.

It should here be mentioned that, at Croydon, although the land there was more liberally irrigated than at Rugby, much more satisfactory results have been obtained with fattening stock fed on the land. The practice there is, to irrigate for three or four days and nights together, to repeat the treatment two or three times for each crop, and, when the grass has got a sufficient head, to stop the application and turn the stock upon the land, where they remain until the grass is closely eaten down. They are then removed, the land is re-irrigated, and so on.

Very much better results were obtained at Rugby when the grass was given to milking cows. Referring to the report of the Sewage Commission for all further details, the summary of the results with cows given in Table IX. will suffice for consideration here.

TABLE IX.

Results obtained at Rugby, with Cows fed on Unsewaged and Sewaged Grass, in 1861, 1862, *and* 1863.

	Plot 1, Unsewaged	Plot 2. 3,000 tons Sewage.	Plot 3. 6,000 tons Sewage.	Plot 4. 9,000 tons Sewage.
Time each acre (with oilcake, if any) would keep 1 cow:—				
	Weeks.	Weeks.	Weeks.	Weeks.
1861—Grass (alone)	19	41	59	69
1862—Grass (with oilcake)......	42	63	73	72
1863—{Grass (½ without, ½ with oilcake.........}	22	48	67	73
Means	28	51	66	71
Milk from the produce of each acre (exclusive of oilcake,* if any):—				
	Gallons.	Gallons,	Gallons	Gallons.
1861—Grass (alone)	321	571	820	961
1862—Grass (with oilcake)	613	835	973	958
1863—{Grass (½ without, ½ with oilcake) ......}	414	876	1207	1327
Means	449	761	1000	1082
Value of milk from the produce of each acre (exclusive of oilcake,* if any) at 8d. per gallon:—				
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1861—Grass (alone)	10 14 3	19 0 6	27 6 11	32 0 10
1862—Grass (with oilcake)......	20 8 10	27 16 10	32 8 11	31 18 10
1863—{Grass (½ without, ½ with oilcake.........}	13 16 0	20 3 9	40 4 7	44 4 4
Means	14 19 8	25 7 0	33 6 10	36 1 4
Increased produce of milk per 1,000 tons sewage applied (exclusive of oilcake*, if any):—				
		Gallons.	Gallons.	Gallons.
1861—Grass (alone)		180	178	151
1862—Grass (with oilcake)......		74	60	38
1863—Grass (½ without, ½ with oilcake)...........................		154	132	101
Means...............		136	123	97
Increased value of milk (at 8d. per gallon) per 1,000 tons sewage applied (exclusive of oilcake,* if any:—				
		£ s. d.	£ s. d.	£. s. d.
1861—Grass (alone)...............		5 19 10	5 18 8	5 0 11
1862—Grass (with oilcake)......		2 9 4	2 0 0	1 5 7
1863—Grass (½ without, ½ with oilcake)...........................		5 2 7	4 8 1	3 7 7
Means...............		4 10 7	4 2 3	3 4 8

It may be stated generally, that when the cows were fed on grass alone, as much as they chose to eat, a given weight of the animal was more productive, both of milk and increase, but especially of milk, on the unsewaged than on the sewaged grass. More milk was also produced from a given weight of the unsewaged grass, reckoned in the fresh or green state, than from an equal weight of the fresh sewaged grass. Of dry or solid substance, however, a given weight of that of the sewaged grass produced, on the average, more milk than an equal weight of that of the unsewaged.

The milk from the cows fed on the sewaged grass was, upon the whole, slightly the less rich, containing generally somewhat less casein, butter, sugar, and total solid matter (though more mineral matter) than that from the unsewaged; but when oilcake was given with the grass, whether sewaged or unsewaged, the richness of the milk was notably increased.

The productive quality of the grass was very different in different seasons, and at different periods of the same season, being very inferior in the wet and cold season of 1862, and towards the close as compared with the earlier periods of the seasons.

Without commenting further on the difference of result obtained under different conditions of season, or under other varying circumstances, it will be sufficient briefly to call attention to the more general results which the records in the table bring prominently to view, and to the practical conclusion which, on a careful consideration of all the circumstances and details, may seem to be safely deducible from them.

It is seen that whether we reckon the total amount of food yielded per acre, or the amount, or the value, of the milk obtained from the consumption of the produce from each acre, there was a very great increase, varying from two to three fold, according to season, by the use of sewage. The land upon which these experiments were made was good feeding pasture, of probably more than average quality, and the natural yield, without sewage,

* The *value* of the milk, "exclusive of oilcake," is reckoned by deducting the cost of the cake consumed, less the estimated value of the manure it yields, from the gross value inclusive of oilcake; and the *amount* of milk, "exclusive of oilcake," by deducting from the gross amount of milk with oilcake at the rate of one gallon for every 8d. of deducted value. Such estimates are, however, obviously only approximations to the truth.

was, therefore, correspondingly high. Taking into consideration this fact, and other circumstances under which the results were obtained, it is concluded that, if not larger amounts of total produce per acre, at any rate larger amounts of increase for a given quantity of sewage may be expected when it is applied systematically over large tracts of land, with a view to the production of grass and milk.

It is estimated that with 5,000 tons of sewage per acre per annum, judiciously applied to Italian rye-grass or meadow land properly laid down to receive it, an average *gross* produce of not less, and perhaps more, than 1,000 gallons of milk per acre per annum might be anticipated; and it may be observed that 1,000 gallons of milk at 8d. per gallon would represent a *gross* money return of £33 6s. 8d.

Putting the result in another way it may be stated that it required, according to circumstances, the consumption of between 5 and 6 tons of grass for the production of 1 ton of milk; and if we reckon 6 parts of grass for 1 of milk, and 30 tons of grass per acre, this would give a *gross* return in value of milk at 8d. per gallon of something over £37 per acre, or of about 5s. per ton, of grass consumed.

Still another illustration of the important bearing of the question of the utilisation of the sewage of our town populations upon the re-production of food may be given. Supposing the whole of the sewage of a given population (which, however, would seldom be the case) were applied exclusively for the growth of grass for the production of milk, the result would be an increased yield of about 2½ pints of milk per week, or about ½lb. per day, per head of such population. So far as the sewage were so applied, a portion of the milk produced would, of course, be represented, in consumption, by its equivalent in butter and cheese. A portion of the grass would, however, be used directly for the production of meat; and, in addition to the milk and meat produced by the consumption of the grass, a large amount of solid manure would be obtained, which would be applicable to arable land for the growth of corn and other rotation crops.

It would appear, then, that if town sewage were to a great extent utilised by the application of something like 5,000 tons per acre per annum to Italian rye-grass and meadow-land, a direct result would be a very greatly increased production of important articles of human food which are at present both scarce and dear. But the question remains—would the sewage, by such an application, be sufficiently purified to allow of the drainage from the irrigated land being turned into rivers which are to be used as a water-supply for other towns? Some light will be thrown on this subject by the results next to be considered.

In order to determine how far, in the experiments at Rugby, the sewage was deprived of its manurial or putrescible constituents in its passage over and through the land, samples of the drainage water were collected for analysis in each field, simultaneously with those of the sewage, commencing in May, 1862, and ending in October, 1863. In all 62 partial analyses of drainage-water, corresponding in detail with those of the sewage, were made. A few other analyses, in much more detail, were made of the sewage and drainage of the season of 1864. The results of the large number of partial analyses are summarised in Table X., which shows, in parallel columns, the average composition of corresponding samples of sewage and drainage.

TABLE X.

Mean Composition of the Rugby Sewage before application, and of the Drainage water from the Irrigated Land, in the Seasons 1862 ***and*** 1863.

Grains per Gallon.

Constituents.	Five-Acre Field. Sewge.	Five-Acre Field. Drnge.	Ten-Acre Field. Sewge.	Ten-Acre Field. Drnge.	The two Fields. Sewge.	The two Fields. Drnge.
Season 1862; May—October, both inclusive.						
	11 samples.	8 samples.	11 samples.	11 samples.	22 samples.	19 samples.
In suspension: Inorganic	25·67	1·81	24·89	3·74	25·28	2·92
In suspension: Organic	14·69	1·40	17·14	1·39	15·92	1·39
In suspension: Total	40·36	3·21	42·03	5·13	41·20	4·31
In solution: Inorganic	34·49	34·50	32·38	37·10	33·44	36·01
In solution: Organic	7·83	7·18	7·60	7·83	7·71	7·56
In solution: Total	42·32	41·68	39·98	44·93	41·15	43·57
Total inorganic	60·16	36·31	57·27	40·84	58·72	38·93
Total organic	22·52	8·58	24·74	9·22	23·63	8·95
Total solid matter.........	82·68	44·89	82·01	50·06	82·35	47·88
Ammonia: In suspension ...	1·37	0·24	1·52	0·33	1·44	0·29
Ammonia: In solution.........	4·13	0·80	4·26	1·85	4·20	1·41
Ammonia: Total	5·50	1·04	5·78	2·18	5·64	1·70

Table X.—*(continued.)*

Constituents.	Five-Acre Field. Sewge.	Five-Acre Field. Drnge.	Ten-Acre Field. Sewge.	Ten-Acre Field. Drnge.	The two Fields. Sewge.	The two Fields. Drnge.
Season 1863; November, 1862—October, 1863, both inclusive.						
	23 samples.	21 samples.	22 samples.	22 samples.	45 samples.	43 samples.
In suspension: Inorganic	39·41	2·14	34·93	3·93	37·22	3·06
In suspension: Organic	27·35	1·41	25·99	3·29	26·69	2·37
In suspension: Total	66·76	3·55	60·92	7·22	63·91	5·43
In solution: Inorganic	39·57	38·55	38·77	41·35	39·18	39·98
In solution: Organic	8·35	7·46	8·30	7·98	8·32	7·73
In solution: Total	47·92	46·01	47·07	49·33	47·50	47·71
Total inorganic	78·98	40·69	73·70	45·28	76·40	43·04
Total organic............	35.70	8·87	34·29	11·27	35·01	10·10
Total solid matter............	114·68	49·56	107·99	56·55	111·41	53·14
Ammonia: In suspension ...	2·08	0·15	1·98	0·31	2·03	0·23
Ammonia: In solution.........	5·83	0·69	5·69	1·85	5·76	1·28
Ammonia: Total	7·91	0·84	7·67	2·16	7·79	1·51

It is seen that of matter in suspension in the sewage, nearly the whole both inorganic or organic, was retained by the soil; and probably a considerable part of the little which the drainage water contained was derived from the soil itself.

Of matter in solution, on the other hand, a gallon of the drainage water contained, on the average, much about the same amount, both inorganic and organic, as a gallon of the sewage; though, doubtless, a considerable portion of the soluble matters in the drainage had their immediate source in the soil—the sewage giving up valuable manurial matters to the soil, and the fluid in its turn taking up substances from it.

It is important to remark that the drainage from the more porous and less naturally fertile soil of the five-acre field (which, however, gave the largest amount of increase for a given amount of sewage), contained loss of almost every constituent, or class of constituents, enumerated, than did that from the more argillaceous and more naturally fertile soil of the more steeply sloping ten-acre field. The result is particularly marked in the case of the ammonia. The fact here indicated is of considerable practical, as well as scientific interest; and it is perfectly consistent with the results of common experience, which tend to show that a soil which may contain a comparatively small proportion of clay, but which is thoroughly porous, is, as a rule, much better adapted for sewage irrigation, both as regards the utilisation and the purification of the sewage, than one which, though richer in clay and of higher natural quality, is but imperfectly permeable by the fluid.

The results given in Table XI. show in more detail the changes in the composition of the fluid in its passage through the soil. They relate to samples of sewage and drainage taken in another field at Rugby, during very dry weather, in the summer of 1864. The plan of collection was, to take of sewage about a gallon, and of drainage about half a gallon, eight or ten times during the ten or twelve working hours of the day; at the end of the day, after well shaking, to take a gallon from each mixture; and to repeat this for six consecutive days until six gallons of each were obtained, when, after well shaking, a two-gallon sample of each was bottled off for the purposes of analysis.

(To be continued.)

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

WHO INVENTED THE SCREW PROPELLER.

To the Editor of The Artizan.

In The Artizan for December last, I notice some correspondence under the above head, in which a claim is set forth on behalf of the late Joseph Ressel as the inventor of the screw propeller. Will you allow me to mention that in the "London Mechanics Register," No. 12, for January 22, 1825, there is a drawing and description of Swan's Rotative Wheels with a letter from Dr. Birkbeck who witnessed the vessel driven by these twin screw propellers as designed by Mr. Swan, then in the employ of Messrs. Gordon of Deptford. I remember the small boat very well and think I also recollect that a barge worked on the Thames in that or the next year fitted with Mr. Swan's propeller and that she laid some time near Roberts', boat builders, at Lambeth.

There can, therefore, be not the slightest doubt that Mr. Swan was the inventor of the twin screw, if not of the screw itself. Mr. Swan worked his propellers from a vertical shaft on each side of the boat, but this was

dono simply for convenience of using the shaft of the paddle engines in his boat; and he distinctly says, thoy could ho driven by a more conveniont and simple mode if desired.

I shall bo happy to think I am able to throw any light upon what is really a national subject.

I am, yours truly,
C. D. CAMPBELL,
Capt., H.M.I.N.

P.S. Whilst I consider that to Mr. Swan is due tho credit of having first applied tho principle of the screw for propulsion, I would wish to be understood as referring to tho application of the screw to work *below* the water; for it is not to bo lost sight of, that Mr. J. Perkins about the year 1821 had a barge working on the Regent's Canal, propelled by double sculls or bevelled blades working across the stern above water in opposite directions by a hollow axis; but they did not stand well, the strain being unequal though the speed was good and no agitation caused to the banks of the canal.—C. D. C.

REVIEWS AND NOTICES OF NEW BOOKS.

Odds and Ends. No. 16, *Spain in* 1866. Edinburgh: Edmonston and Douglas, 1866.

ANOTHER of those admirable brochures, which from time to time issue from the publishing office of Messrs. Edmonston and Douglas, of Edinburgh. Clear and telling, if not pungent, in style, with facts carefully collected and succinctly stated, and truthful to a degreee, the picture of Spain, painted in words by the author, pourtrays the actual condition of that truly magnificent, but unhappy country, as thoroughly as many volumes or thousands of pages of letter press could do. The portions devoted to the mineral wealth of the country, the commercial products, railways, irrigation, &c., pp. 28—39, are (from personal knowledge of the country, we can vouch) highly interesting and accurate.

The Glasgow Water Works. Papers read during session, 1863-64 at the Institution of Engineers in Scotland. By JAMES M. GALE, M. Inst., C.E. Glasgow: Bell and Bain, 41, Mitchell-street, 1864.

This series of papers upon so interesting and extensive a public work will prove a useful book of reference to engineers and others engaged in supplying towns with water, as whilst the textual matter enters minutely into all the details and considerations of importance, the numerous figures in the several plates supply the best possible illustrations of the mode in which such works are necessarily carried out in practise.

Iron Work. Formulæ and General Rules for Finding the Strain and Breaking Weight of Wrought Iron Bridges. By CHAS. HUTTON DOWLING, C.E., formerly of Trinity College, Dublin. London: John Weale, 59, High Holborn.

This is another of Mr. Weale's very successful series of scientific and practical handbooks that commend themselves to the engineer and student not only for their exellence, but their cheapness, a combination rare in books as in other things. Mr. Dowling supplements the formulæ and rules given, with short descriptions of the Niagara Suspension Bridge, and the proposed railway bridge across the Firth of Forth; and he concludes by giving a series of very useful tables.

Formulæ, Rules, and examples for Candidates for the Military, Naval and Civil Service Examinations, also for Mathematical Students and Engineers. By T. BAKER, C.E. London: John Weale, 59, High Holborn.

An admirable collection of formulae, rules and examples in every hranch of mathematics, well chosen and arranged, the alphabetical order adopted greatly facilitates speedy reference, a desideratum that will be appreciated by every student. Indeed it is a very handy work

Useful Information for Engineers, third series. By WILLIAM FAIRBAIRN Esq., C.E., L.L.D., F.R.S., F.G.S., &c. London: Longmans, Green and Co. 1866.

More than usual interest attaches to this last book by Dr. Fairbairn, interesting and highly useful as all his books have invariably been. As recognised branches of engineering, electric telegraphy generally, and submarine telegraphy in particular have now established themselves firmly, and the author of Useful Information for Engineers—has devoted no inconsiderable space to these subjects.

The first portion of the present book is devoted to a series of six lectures; and very interesting and readable lectures they are. They occupy 122 pp. The remainder of the volume, or about 200 pp., is divided into two parts; in the first the subjects treated are—the comparative merits of the machinery in the Paris Exhibition 1855; on the machinery department of the International Exhibition of 1862 (in London), on the construction of iron roofs (and in which some excellent examples are given). In part two Circular Roofs are treated; the experimental researches on insulation and other properties of submarine telegraph cables are very fully detailed; the mechanical properties of the Atlantic Cable are admirably treated of; results of experiments to determine the effect of impact, vibratory action, and long continued and recurring changes of load on wrought iron girders, which are of great value to the mechanical engineer, contractor, and constructor of such works; and finally, the appendix gives some of the causes of the failure of deep sea cables. In this appendix Dr. Fairbairn gives some reasons why the *Great Eastern* possesses advantage over other vessels for laying telegraph cables. In THE ARTIZAN for October 1st 1856, the original suggestion was made for the employment of the *Great Eastern* for such a purpose. The third series of useful information for engineers, is a valnable and acceptable addition to the Engineers' Library.

NOTICES TO CORRESPONDENTS.

N. G.—By adding to the copper a quantity of tin varying from 12½ to 15 per cent., or say from 2oz. to 2½oz. of tin to each pound of copper, you will obtain a composition suitable for your purpose.

NAUS.—In adopting the length you have determined upon for your boat, the beam should not be less than 10ft., but it may reach up to 11ft. 6in., or even 12ft. A depth of hold of 6ft. will answer.

ENQUIRER.—Neither Routledge's nor any other slide rule can be used for such a purpose. Its applicability is confined to operations pertaining to multiplication, division, involution, and evolution. Most slide rules manufactured in this country are adapted only for the extraction of square roots, not cubic roots. For powers and roots of large numbers, it is more advisable to resort to the tables usually given in engineers' pocket books.

F. D.—We recommend Fairbairn's "Useful Information." You will find the work is noticed in our present issue.

H. R. W—n.—Diesmal nicht Raum genug. Næchtes Mal.

PRICES CURRENT OF THE LONDON METAL MARKET.

	Dec. 1.			Dec 8.			Dec. 15.			Dec. 22.		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, selected, per ton	89	0	0	84	0	0	84	0	0	84	0	0
Tough cake, do.	86	0	0	81	0	0	81	0	0	81	0	0
Copper wire, per lb.	0	0	11¾	0	1	0	0	1	0	0	1	0
„ tubes, do.	0	1	0¼	0	0	11½	0	0	11½	0	0	11½
Sheathing, per ton	91	0	0	86	0	0	86	0	0	86	0	0
Bottoms, do.	96	0	0	91	0	0	91	0	0	91	0	0
IRON.												
Bars, Welsh, in London, per ton	7	0	0	7	0	0	7	0	0	7	0	0
Nail rods, do.	7	10	0	7	10	0	7	10	0	7	10	0
„ Stafford in London, do.	8	7	6	8	7	6	8	7	6	8	7	6
Bars, do.	8	7	6	8	5	0	8	5	0	8	5	0
Hoops, do.	9	7	6	9	5	0	9	5	0	9	5	0
Sheets, single, do.	10	0	0	10	0	0	10	0	0	10	0	0
Pig, No. 1, in Wales, do.	4	5	0	4	5	0	4	5	0	4	5	0
„ in Clyde, do.	2	14	6	2	14	9	2	15	0	2	15	0
LEAD.												
English pig, ord. soft, per ton	20	5	0	20	5	0	20	5	0	20	5	0
„ sheet, do.	21	0	0	21	0	0	21	0	0	21	0	0
„ red lead, do.	23	10	0	21	10	0	21	10	0	21	10	0
„ white, do.	27	0	0	27	0	0	27	0	0	27	0	0
Spanish, do.	19	10	0	19	10	0	19	10	0	19	10	0
BRASS.												
Sheets, per lb.	0	0	10¼	0	0	9¾	0	0	9¾	0	0	9¾
Wire, do.	0	0	8¾	0	0	8½	0	0	8½	0	0	8½
Tubes, do.	0	0	11	0	0	10¾	0	0	10¾	0	0	10¾
FOREIGN STEEL.												
Swedish, in kegs (rolled)	14	0	0	14	0	0	14	0	0	14	0	0
„ (hammered)	16	0	0	16	0	0	16	0	0	16	0	0
English, Spring	19	0	0	19	0	0	19	0	0	19	0	0
Quicksilver, per bottle	6	18	0	6	18	0	6	18	0	6	18	0
TIN PLATES.												
IC Charcoal, 1st qu., per box	1	14	0	1	14	0	1	14	0	1	14	0
IX „ „ „	2	0	0	2	0	0	2	0	0	2	0	0
IC „ 2nd qua., „	1	10	0	1	10	0	1	10	0	1	10	0
IC Coke, per box	1	4	6	1	4	6	1	4	6	1	4	6
IX „ „	1	10	6	1	10	6	1	10	6	1	10	6

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Penn *v.* Jack.—Penn *v.* Bibby.—These suits involved the question as to the novelty of the plaintiff's patent for the application of wood bearings to screw propellers. The grounds of objection to the patent were in effect want of novelty, insufficiency of the specification, and that the subject was not a proper one for a patent. One of the chief grounds on which the novelty of the patent was disputed was that the identical thing had been used in the year 1851, in a vessel called the *Livorno*, the patent itself having been taken out only as late as 1854. Vice-Chancellor Wood's decision in favour of the plaintiff was fully reported in our issue of June 1st., 1866. On the part of the defendants a motion for a new trial was brought before the Lord Chancellor. After several days' argument, his Lordship confirmed the decision of the Court below, and dismissed the appeal.

Mallett's Patent.—Mr. Robert Mallett applied to the Lords Justices of the Judicial Committee of the Privy Council for a renewal of his patent for improvements in fireproofs in buildings and other structures. The patent was granted in 1852 for fourteen years, and the petitioner asked for a renewal, as great difficulty had occurred in bringing it before the public. The matter was fully gone into before their lordships, and accounts produced showing that the invention was becoming of value to Mr. Mallett, and he therefore prayed for a prolongation of the patent. It appeared that he had granted a licence to a Mr. Jones. About £4,000 had been gained by Mr. Mallett by his invention. Lord Justice Turner, after a conference with the other members of the Committee, said the invention was one of public benefit, and if the public would lose by a prolongation, they would be gainers in another point of view by Mr. Mallet carrying out his own invention. Their lordships would extend the patent for four years, and clothe their order with the provision that similar licences to the one granted to Mr. Jones might be made to other persons for the benefit of the public. Order accordingly.

Morgan *v.* Macadam.—The plaintiffs, Messrs. Morgan Brothers, carrying on business as plumbago crucible makers at Battersea, acquired by purchase, in 1856, the right of manufacture, whereby plumbago crucibles were produced of better quality than heretofore,—it having been stated to them that the secret of the process was originally covered by patent rights in the United States. As, in the plaintiff's opinion, such patent would have had no force in this country, they thought that, having purchased the secret, they were fully entitled to adopt the designation, "Patent Plumbago Crucible Company," and embody the same in their trade mark. However, having made further improvements in the manufacture of the article, they took out a British patent for such improvements in 1863, whereby, as they allege, the style and title of Patent P. C. Company was doubly justified. The defendant having adopted the identical trade mark for plumbago crucibles of his make, Messrs. Morgan applied to Vice-Chancellor Wood for an injunction to prohibit the defendant from using such trade mark. His Honour, without hearing the counsel for the defence, dismissed the application on the ground that the introduction by the plaintiff of the word patent in the trade mark in question, was not justified from the outset, and that the plaintiffs, although they had patented their process in 1863, admitted not to adhere invariably to the terms and provisions of such patent in their mode of manufacturing the article.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

New Order in Patent Matters.—The following notice has just been issued by the Lord Chancellor, the Master of the Rolls, and the Attorney aud Solicitor General, on behalf of H.M.'s Commissioners of Patents, for inventions:—After the 31st day of December, 1866, every applicant for letters patent shall deliver at the office of the Commissioners, with his provisional specification, or (when a complete specification is filed with the petition and declaration) with his complete specification, an abridgment, in duplicate, under his hand or the hand of his agent, of such provisional or complete specification. The abridgment must set forth the name of the applicant, the title of the invention, and describe, in as short a manner as possible, the features of novelty which constitute the invention. The abridgment and the copy thereof must be written upon sheets of foolscap paper, and upon one side only of each page, leaving a margin of 1½in. on the left-hand side of the page. (Signed) Chelmsford, C., Romilly, M. R., John Rolt, John B. Karslake. Dated the 17th day of December, 1866.

Coal in France.—During 1865 Rouen consumed 90,728 tons of French and Belgian coal; but Hâvre, Fécamp, and the other seaports of the department of the Lower Seine imported 585,819 tons of coals from English mines. With all the facilities of transport now existing, English coal cannot be had in Paris under £2 a ton, and for the interior of France the height of the custom duties proves still almost as prohibitive as it was previous to the "free trade" treaty of 1860.

Safety-Valve for Steam-Boilers.—Mr. Henry Anderson, of Chicago, Ill., U.S., proposes a safety-valve which is held in position by a volute or other spring placed in the interior of the boiler; the valve is provided with a stem, which extends through a socket in a bridge on the inner surface of the dome cover in such a manner that the valve operates free and easy, and the spring which holds it in position is out of reach of the engineer or person in attendance, and cannot be tampered with.

Petroleum as Fuel.—The scheme proposed by Mr. E. M. M'Kinney, of Clarkville, U.S., for feeding stoves, furnaces, &c., with petroleum as fuel, consists in the employment of water, or other fluid having a greater specific gravity than petroleum, and placing the former in an elevated tank or reservoir communicating with the lower part of the petroleum chamber by means of a pipe, so that the petroleum will be fed to the fire-pan or chamber by static pressure.

Postal Communication with the United States.—From a parliamentary paper recently issued, it appears that the passage from Liverpool to New York by the Cunard mail steamers occupies 12 days 11 hours, at an average speed of 10·58 knots per hour. The homeward passage is usually performed in 11 days 7 hours, at an average speed of 11·48 knots. In the year 1861 the *Persia* made seven voyages out and eight home at an average speed respectively of 12·15 and 12·91 knots per hour, thus performing the journey in little over 10 days each way. The Cunard mail ships between Liverpool and Boston attain a less rate of speed, averaging 13 days, at the rate of 9·77 knots per hour on the outward, and 11 days, at the rate of 10·8 knots, on the homeward passages.

The Iron Manufacture of Prussia.—The number of forges aud large foundries in Prussia amounted in 1861 to 1421, of which 1096 are of a certain importance. The total production amounted to 1,610,000 tons of common metals, and 56,701lbs. of silver, representing a value of £5,846,187. The workmen were 80,470 in number, reckoning with their families 237,970 individuals.

Price of Pale Ale.—In some observations which have gone the round of the newspapers on the rise in the price of bitter beer announced by the great Burton brewers, it is remarked that a similar increase took place in 1860, but "was taken off in the next year in consequence of a general remonstrance of the trade." This is not the fact. The season of 1860, as that of the present year, (both in barley and hops) was exceedingly unfavourable to the crop of hops; the price for which rose to an extent that would have given a profit on hops in store to more than one Burton brewer of £60,000 a year, could they have altogether suspended brewing and sold hops and not ale. But the necessities of business compelled them to supply their customers, with whom, as on this occasion, they then shared the loss. In the next year there was a good crop of barley and hops, and to this and not to any remonstrance of the trade—which was not needed, and not made—was the reduction in price attributable. There was then, at first, on the increase in price, as there will be now, some grumbling at the alteration; but on the necessity being made known, and the reasons given, the trade recognised, then as now, the fact that it could not be from seeking their own advantage that the brewers would raise their prices, and so displease customers; once satisfied on this point, they remained, as now, content to abide a better season.

The Iron Trade of France.—The bulletin of the French ironmasters gives the following account of the importation and exportation of cast and wrought iron during the ten years ending with 1864; the quantities set down under the years 1855, 1860, and 1864, serve to give an excellent comparative idea of the trade previous to and since the execution of the Treaty of Commerce.

Importation of pig-iron and castings	125,876	72,219	113,491
Exportation of the same kinds	2,876	19,885	25,060
Importation of wrought iron and iron plates	58,381	21,573	64,752
Exportation of the same kinds	13,423	62,800	121,011

The fact of the exports of the French ironmasters having largely increased is satisfactory for them, while the other facts, namely, the actual increase of the imports into France of wrought iron, and the small diminution of the amount of cast iron imported, are qualified additional proofs of the expediency of the system of free trade adopted in France since 1860.

Steam Rollers in Macadamisation.—The First Commissioner of Works has ordered a steam roller from Messrs. Aveling and Porter, of Rochester, for flattening the macadam on the roads of the Royal parks of London. It is of 12-horse power, weighs 20 tons, and has rollers 7ft. in diameter by 3ft. in breadth; the weight upon each foot of road will be three tons. This roller has been in use in Hyde Park for some time past.

LAUNCHES.

Launch of the Malabar.—On Dec. 8th, the iron screw troopship, *Malabar*, built by Messrs. R. Napier and Sons, was successfully launched from their yard at Govan. The *Malabar* is one of the five troopships intended for the improved Indian relief service, by way of Alexandria and Suez. By the employment of these vessels much time will be saved as compared with the route by the Cape, and the comfort and health of the troops will be better provided for. Each of them is designed to convey about 1,450 persons, including 1,250 soldiers. It is proposed that two shall do service between England and Alexandria, two between Suez and the Indian ports (the *Malabar* being one of these), while the fifth shall be held in reserve for particular emergency. The five ships have been designed under the direction of Mr. R. J. Reed, the Chief Constructor of the navy, to carry out the requirements of the Transport Board, submitted by Captain Mends, R.N., and have been carefully adapted for the intended service. It is stated that they provide the greatest possible space and best sanitary arrangements for soldiers and passengers, together with the highest rate of speed compatible with the necessary stowage for military stores and coals, on a draught of water not exceeding 21ft. The principal dimensions of the *Malabar* are:—Length between perpendiculars, 360ft.; breadth, 49ft.; depth amidships, 34ft. 6in.; tonnage, 4,173. Her engines, designed and constructed by her builders, are of 700 horse-power nominal. They are of the horizontal direct-acting type, and fitted with surface condensers (Davison's patent), and other modern improvements. The cylinders are 94in. in diameter, steam jacketed, and have a stroke of 4ft. Four tubular boilers, with superheating apparatus, will be placed on board. The speed expected from the five vessels is about 14 knots per hour at deep draught. The bunkers of each will contain coal for 15 or 16 days' consumption. The remaining vessel, the *Crocodile*, building by Messrs. Wagram, is, we believe, expected to be launched shortly.

Launch of the "Sir Herbert Maddock."—The steamer *Sir Herbert Maddock*, the property of the Indus Flotilla Company, was launched from the company's building yard at Kurrachee, East India, on October 9th last. The *Sir Herbert Maddock* was built by Messrs. J. Wigham Richardson and Co., of Newcastle-on-Tyne, and her engines are by Messrs. Morrison and Co., of the same place. The dimensions of this vessel are as follows:—Length between the perpendicular, 272ft.; breadth of beam, 29ft.; depth of hold, 8ft.; working draft, 2ft. 10in. She is fitted with oscillating engines of 280 nominal horse power—the cylinders being 65in. in diameter, and the piston stroke 54in. Her paddles are 21ft. in diameter. Next to the *Talpoor*, this is believed to be the largest vessel hitherto launched at Kurrachee. The hull of the steamer, as well as her engines, had been erected by workmen sent from England for that purpose.

SHIPBUILDING.

Shipbuilding in South Wales.—The shipbuilding trade in South Wales is recovering to some extent from the late depression. At no period during the monetary panic did it suffer to anything like the extent as was the case in the north of England, and at the present time the various yards are fairly employed. At Cardiff and Swansea there are several ships under hand, while at Newport there are four or five almost ready for launching, and the keels of three or four other vessels have been laid. In consequence of a very large number of foreign ships having visited the several ports for iron and coal cargoes, the repairing branch of the trade has been exceedingly good, the same as the earnings of the gridirons for the last quarter of 1865. The iron-shipbuilding yards at Newport, Cardiff, and Llanelly are also moderately employed, and at the first-named port, Messrs. Spittle and Co., are constructing an iron-clad ship of about 1,600 tons burden, which will be ready to leave the stocks at the commencement of the new year.

Steam Shipbuilding on the Clyde.—Messrs. Thomson have received on order to build a screw-steamer of about 3,000 tons for the fleet of Messrs. Burns and M'Iver.—The *City of London*, one of the line of the Liverpool, New York, and Philadelphia Steamship Company, has been sent round to the Clyde to be lengthened 30ft., and also to receive new engines and boilers.—Messrs. Dobie and Co., of Govan, have launched an iron screw-steamer of 500 tons, builder's measurement, named *Le Colon*. After the launch *Le Colon* was towed to Port Glasgow, where she is being supplied with engines of 90 horse-power, by Messrs. Blackwood and Gordon. This vessel has been built for the "Compagnie anonyme de navigation mixte de Marseille."—Messrs. Denny and Bros. have launched a new steamer named the *Cairo*, of 1,484 tons burden, and of the following dimensions:—length 255ft., breadth 32ft., and depth to spar deck 26ft. 6in. The *Cairo* will be fitted with direct-acting surface condensing engines of 200 horse-power nominal; she is intended for the Eastern trade.

RAILWAYS.

The Atlantic and Pacific Railway, from New York to San Francisco, will be 3,200 miles long. It passes through St. Louis. Kansas City, the heart of New Mexico, and gets into California, near the head waters of the Colorado River, by a low pass in the Rocky Mountains. The railway is rapidly being made from both termini. By January, 1868, it will be extended 1870 miles from New York, to within 200 miles of the Rocky Mountains. In two or three years' time a person will reach San Francisco from England in little over a fortnight, and he will have made during that period an ocean voyage 3,000 miles long, and performed a land journey of greater length. When the Atlantic and Pacific Railroad is completed, the route from this country to Japan and China, *via* New York and San Francisco, will be much the best and quickest one.

Springs for Railway Engines.—Mr. S. Moulton, of Bradford, Wilts, proposes to embed in the cross section of a hollow or solid cylinder of India-rubber, rings or washers of metal or other hard material. These rings give greater firmness to the India-rubber cylinder when employed as a spring. He perforates the rings so that the India-rubber may be connected through the openings. The whole mass is secured in the ordinary way.

The Mont Cenis Tunnel.—It is estimated that the number of holes which will have to be drilled by the rock-boring machines in the Mont Cenis tunnel, before that work is completed, is about 1,600,000. The total depth of all these holes when bored will amount to about 4,265,890ft. which is 105 times the length of the tunnel. Nearly 13,000,000,000 blows will be struck by the operators to do this work. The entrance to the tunnel on the French side is 3,946ft. above the level of the sea, and its termination on the Italian side 4.380ft., so that the actual difference of level between the two extremities is about 434ft.

Wood Superseded in the Construction of Railways.—While the Bessemer steel is pushing out iron in the making of rails, iron, on the other hand, is being substituted for wooden sleepers, and every day proves the advantage of the latter. In 1862, Herr Heusinger von Waldegg, in a work entitled "Die eiserne Eisenbahn," proposed an elaborate plan for substituting iron for wood in all accessories and appurtenances of railway lines. It appears that his system is gaining ground in Germany. An experiment of forming a line entirely of iron is being tried at the present moment on the Rhenish Railway, near the Coblentz Station, by the director of the company, M. Hartwick. The rail is of the Vignoles form, with a case of the ordinary width, but nearly 10in. high. The weight of the rail is about 1cwt. per metre, or 34lb. per foot; it lies directly on the ballast, and the two irons of the same way are simply connected by stretching rods of round iron, 1-3-eighths in. diameter, bolted close up underneath the head of the rail. This rail resembles the Barlow rail, and the reputation of M. Hartwick as an engineer is considered a guarantee of its success. The Mediterranean Company has ordered of the Menans Iron Company, in Franche Comté, ten thousand iron sleepers. Those to take the joints weigh 113lbs., and the others 85lbs. each; the prices are 13f. 60c. for the former, and 10f. 50c. for the latter. In other words, they will cost just about £10 a ton, delivered at the railway station. These sleepers are now on trial on the main line, near the station of Maison Alfort. The same works have also received an important order from the Northern Railway of France for 6,000 iron sleepers at 9f. each, delivered at the company's stations: each of these sleepers weighs 77lb., which brings the price up to about £10 2s. 6d. per ton.

DOCKS, HARBOURS, BRIDGES.

Iron v. Wood for Lock Gates.—The policy of substituting iron for wood in the construction of canal locks and sluice-gates is being discussed with some warmth by the engineers of the Corps des Ponts et Chaussées in France. In some quarters it is urged that the present wood constructions should be superseded by iron ones, on account of the constant costs of repair of the latter. The iron gates of the locks of Decise and Mulhouse are quoted as proofs of the superior economy of iron. The iron gates of the Canal Saint Maurice cost £7 4s. the square metre, while wooden gates of the same kind cost from £6 to £6 4s., only about one-fifth less. Other engineers maintain that in the case of small canals the use of iron would only involve unnecessary expenditure; but as the chief item of expenditure consists not of the cost of erection, but the maintenance of the construction, it is to be expected that the opinion of those advocating the use of iron will eventually prevail.

Improvements of the River Ribble and the Construction of Docks, &c., at Preston.—Messrs. R. B. Bell and D. Miller, civil engineers, of London and Glasgow, have issued a very carefully elaborated report drawn up in accordance with instructions received by them from the Mayor and Corporation of Preston, to examine the River Ribble and the port of Preston, with a view to elucidate their views as to the capabilities of the port and river improvement, so as to enable the Mayor and Corporation to form a judgment as to the propriety of construction of wet docks and of making other improvements. Messrs. Bell and Miller divide their report under the following heads, each of which is treated in a thoroughly exhaustive manner, viz.: Of the former state of the River Ribble and improvements hitherto effected; the present harbour accommodation; the present trade of the port; the present state of the River Ribble with reference to its capacity for future improvement; the nature of the proposed floating accommodation; comparison of the Ribble with other rivers. The whole is terminated by the "General Conclusions" arrived at by Messrs. Bell and Miller, at the termination of which they say, —That however beneficial the result of these improvements may ultimately be to the interests directly connected with the harbour or the river navigation, the collateral advantages to Preston generally—in the creation and development of mercantile pursuits, shipbuilding, engineering works, shipowning, and the numberless industries connected with an important seaport, and in the increase of population and the enhanced value of property—would be a hundredfold greater, and would therefore have an important influence on all classes of the community.

Proposed New Docks at Liverpool.—Extensive new docks, in addition to those under the control of the Mersey Docks and Harbour Board, are now proposed by the London and North-Western Railway Company at Garston, about six miles above Liverpool, on the Lancashire side of the Mersey. Active measures are in course of being taken by the railway company. The establishment of these new docks is expected to meet with strenuous opposition from the Mersey Dock Board, as their construction would necessarily interfere with the shipping interest of Liverpool. The railway company mentioned are already the owners of a large dock at the spot indicated, and such has been the increase of the trade at Garston Dock that it has already ceased to afford adequate accommodation to the trade carried on there and in the immediate neighbourhood. It is now almost continually full, and it is no uncommon thing to find from twelve to twenty vessels detained in the river to await the convenience of the Garston Dock. Under these circumstances the London and North-Western Railway Company are in the ensuing session about to apply to Parliament for powers to construct two additional docks to provide for the rapidly-expanding trade of the district. The company propose to construct one dock to the north and one to the south of that which they already possess. In connection with the proposed north dock, they are applying for powers to make an embankment and sea-wall, to commence at the present dock and run 380 yards in a north-westerly direction, and 245 yards in a north-easterly direction, along the foreshore of the Mersey. The contemplated extension of the Garston Dock provides for several acres of additional water space and a great increase of quay and shed accommodation. Should the projected scheme receive the sanction of Parliament and be carried out, it will provide accommodation for about 500 vessels of the average tonnage of those now frequenting the Garston Dock.

MINES, METALLURGY, &c.

The Mineral wealth of Colorado.—Mr. Evans, ex-governor of the territory of Colorado, gives his view of the mining prospects of that region, in highly flavoured trans-Atlantic fashion, as follows:—"Lying along the great Cordilleras, or snowy range, which divides the waters of the Atlantic from those of the Pacific Ocean, directly west of Denver City, extending from near the base of Long's Peak, in a southerly direction, for over two hundred miles in Colorado, is what I believe to be the most extensive and richest mineral belt of country in the world. From five to fifteen miles wide, for this vast extent the mountains are literally gridironed with gold, silver, copper, and lead-bearing lodes, many of them known to be of great extent and unsurpassed richness. . . . I believe that enough mines that are extensive and rich have already been discovered, to give profitable employment to a million of men."

Making Iron Direct from the Ore.—As a remedy for the defects in the ordinary process of manufacturing iron direct from the ore, Mr. C. M. Duprey proposes that the ore first freed, as far as possible, by water or otherwise, from its earthy impurities, should be placed in a crushed state with pulverised charcoal in thin sheet-iron canisters, in quantities sufficient, when reduced, to form a mass of iron of the usual weight of a puddle ball. An ordinary sand bottom iron-heating furnace is brought up to a reducing heat, and with a thick clear fire the canisters are introduced. The furnace is carefully maintained at a reducing heat in the usual manner by small additions to the fire from time to time, as required, and by a careful exclusion of the atmosphere. Very little blast and a suppressed draft are used, so as to furnish a reducing heat without cutting the canister. The operation resembles very closely the process for annealing sheet-iron. Soon after introduction the canister is annealed and toughened, so as to assume a polished appearance. It should be the aim to keep the heat in this condition until the metal is thoroughly reduced: should it be increased the canisters may be prematurely destroyed. Deoxidation commences immediately on the introduction of the ore, as proved by the blazing of carbonic oxide from vents made for the purpose, and, by occasionally rolling, and at the proper time compressing the canister, the oxidation is caused to continue without intermission, until reduction is completed. The heat should then be raised to weld or paste together the particles of iron, and then canister and contents, being withdrawn, are welded, in any of the ways puddle ball is usually treated. The whole operation need not last longer than from four to six hours, and it is estimated that, allowing for all possible contingencies, a saving of fully 30 per cent. on the present cost of the production of iron would be effected.

Coal Produce of the United Kingdom.—The following interesting facts are taken from a paper entitled "What we owe to our Coal measures," recently read by Mr. D. Page, F.G.S., at the Literary and Philosophical Society of Newcastle-upon-Tyne: The total coal produce of Great Britain and Ireland in 1840, was 34,000,000 tons; in the years 1857 and 1865 it was as follows, in each of the component parts of the kingdom:—

	1857. tons.	1865. tons.
Durham and Northumberland	15,826,525	25,032,694
Cumberland	942,048	1,431,637
Yorkshire	8,875,440	10,846,000
Derbyshire and Nottinghamshire	3,687,442	4,200,350
Warwickshire	398,000	859,000
Leicestershire	698,750	965,500
Staffordshire and Worcestershire	7,164,625	12,200,000
Lancashire	8,565,500	11,962,000
Cheshire	750,500	850,000
Shropshire	750,000	1,135,000
Gloucestershire, Somerset, and Devonshire	1,225,000	1,875,000
North Wales	1,046,050	1,983,000
South Wales and Monmouth	7,132,304	12,036,587
Scotland	8,211,743	12,650,000
Ireland	120,630	123,500
	65,395,707	98,150,587

APPLIED CHEMISTRY.

Products of Petroleum—Chimogene.—By condensation of the gases first coming off from petroleum, Prof. P. H. Van der Weyde, of Girard College, U.S., has succeeded in obtaining a liquid which boils at only 40°, and produces most intense cold upon evaporation: it has been named Chimogene. By applying heat to the petroleum, and gradually increasing it, there is obtained in succession—gazoline (an inflammable and explosive liquid, which may be used without danger in metallic lamps filled with sawdust), naphtha, benzine, kerosene, and paraffin, leaving only a coke, which differs widely from coal-coke, behind. Petroleum itself is the best lubricator known, and is applicable alike to the most delicate mechanism and to the heaviest machinery; whilst by slow distillation, at a low temperature, hair-oil, liniment, and a petroleum castor oil, are obtained; and from petroleum benzole, treated with a suitable acid, "extract of bitter almonds" is produced, and largely used for flavouring.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of The Artizan."

Dated November 9th, 1866.

2918 D. Crichton, D. Crighton and W. Donhavand—Looms for weaving
2919 W. Cassap—Expediting the putting out of ships' boats
2920 S. W. Woodroffe—Construction of privies
2921 J. H. Johnson—Fastenings or couplings
2922 F. B. Doering—Engines for boring rock and other mineral, and frames for boring engines
2923 W. E. Newton—Pocket knives
2924 W. E. Newton—Treating vegetable substances

Dated November 10th, 1866.

2925 A. Gobert—Lubricating axle-trees of fixed engines
2926 H. A. Bonneville—Purifying foul waters
2927 H. A. Bonneville—Apparatus for pumping
2928 H. A. Bonneville—Coffee hullers
2929 H. A. Bonneville—Greasing apparatus to diminish friction
2930 H. A. Bonneville—New sorter and drilling machine connected therewith
2931 H. A. Bonneville—Apparatus to excavate
2932 G. Little—Instruments for transmitting telegrams between remote places
2933 W. Robertson and C. J. Waddell—Carding engines
2934 G. White—Steam engine
2935 H. Hitchins—Cutting stone for building purposes
2936 F. B. Donisthorpe—Finishing parts of woollen garments
2937 G. Josse—Ornamenting and producing certain figured and embossed surfaces for various useful purposes
2938 J. F. Caulkins and W. J. Armstrong—Ships' anchors
2939 T. Skaife—Vibrating lightening lamp for the obtaining of photograms
2940 N. Korshunoff—Manufacture and casting of iron and steel, and furnaces and apparatus employed therein
2941 R. Lakin and J. Wain—Machines for spinning and doubling cotton and other fibrous materials
2942 J. G. Tongue—Cutting and heading nails
2943 J. H. Johnson—Manufacture of chains, and machinery employed therewith
2944 J. H. Johnson—File cutting machines
2945 W. G. E. Swinnock—Lace fabrics
2946 W. Clark—Breech loading firearms and cartridges
2947 G. Crawshay and J. Thomas—Treatment of scoria or slag of copper ores
2948 G. Crawshay and J. Thomas—Refining pig or cast iron for puddling into wrought iron
2949 J. Denley—Chimney tops for preventing the down draught of smoke

Dated November 12th, 1866.

2950 W. Pidding—Manufacture of bricks, and uses of the same
2951 G. Perry—Lockets, brooches, &c.
2952 D. Murray—Lowering boats
2953 J. Ingham and H. Stapper—Testing the lubricity of oils and other lubricants
2954 W. Routledge and F. F. Ormanney—Cutting coal, boring rocks, or other substances
2955 G. F. Freeman—Composition roller for calico printing
2956 J. Bentley and W. Hampson—Stretching woven fabrics during the processes of stiffening, sizing, drying, or finishing them
2957 G. Crawshay and J. Thomas—Treatment of titauiferous iron ores
2958 A. V. Newton—Coal oil lamps
2959 J. R. Cadman—Means of forming joints between sashes, &c.
2960 A. Hawkins—Forming ornamental and other devices on and in marble, stone, and other substances
2961 J. C. Stevenson and G. T. France—Manufacture of soda or alkali
2962 H. Crawford and J. Crawford—Finishing thread and yarns, and machinery employed therefor

Dated November 13th, 1866.

2963 T. Molineux—Improvements in pianofortes
2964 L. Brierley—Metallic bedsteads, cots, and couches
2965 G. Whitehead—Chimney tops or cowls
2966 C. Moseley—Machinery for the manufacture of india rubber thread
2967 W. S. Macdonald—Method and means of cleansing textile and other fabrics and materials
2968 J. Harding—Machines for doubling cotton and other fibrous materials
2969 A. Schoiey—Nails or fastenings
2970 J. G. Tongue—Breech-loading firearms
2971 C. E. Brooman—Method of and arrangement of engine for towing barges and other vessels
2972 W. Clark—Treatment of materials for the manufacture of various useful articles
2973 F. W. Dahne and D. Thomas—Improvements in picks or mandrils
2974 J. P. Brown—Application of bedsteads to apartments
2975 W. W. Marston—Carving wood, &c., to the shape of a pattern

Dated November 14th, 1866.

2976 J. F. Belleville—A new spring regulator
2977 E. J. Payne—Mode of authenticating telegraphic dispatches
2978 J. Whitehead—Looms for weaving
2979 C. M. Bathias—Registering the speed of machinery or the distance travelled by vehicles
2980 H. A. Bonneville—Apparatus to teach book keeping
2981 H. A. Bonneville—Treating a certain bark for the production of a fibrous substance known in commerce by the name of vegetable silk
2982 W. Clapperton—Multiple drilling machines
2983 T. S. Truss—Construction of pipes, and joining the same, for the transmission of gas and other fluids
2984 J. Clark—Railway breaks
2985 H. Hughes—Manufacture of tubes and other articles, and apparatus employed therein
2986 T. Page—Locomotive engines and their permanent ways
2987 W. Clark—Improvements in locks
2988 J. C. Morrell—Construction of dry closets, and apparatus for preparing manure

Dated November 15th, 1866.

2989 W. A. Lyttle—Steam generators
2990 W. R. Lake—Looms for weaving
2991 H. Lampson—Connecting together the ends of iron and other metal bands used in baling cotton and other bale goods packed under pressure
2992 T. Vaughton and O. Vaughton—Construction of articles of jewellery
2993 W. N. Atkinson—Power looms
2994 J. Erskine—Steam engines
2995 J. Nichols—Wringing yarns
2996 E. C. Hodges—Breech loading firearms
2997 L. Bernieri—Photography
2998 E. Humphrys—Machinery used in propelling vessels
2999 T. B. Daft—Constructing harbours
3000 J. Kemble—Marking railway and other tickets
3001 E. Dawson—Consumption of smoke, &c.
3002 W. Grune—A chemical decoration on gold, silver, and other similar metals, and colours on porcelain, &c., called Grune's proceeding

Dated November 16th, 1866.

3003 J. Sellers—Looms for weaving
3004 E. Drucker—Combined punching and eyelet machine
3005 G. Davies—Method of and apparatus for stopping or closing vessels
3006 G. Davies—Inkstands
3007 J. H. Johnson—Coverings for floors
3008 J. Vero—Boots and shoes
3009 A. V. Newton—Ladies' skirts
3010 C. E. Brooman—Spinning machinery
3011 R. Woollatt—Instrument to be employed in producing local anæsthesia
3012 J. M. Dunlop and F. Crossley—Cutting india rubber

Dated November 17th, 1866.

3013 J. W. Hurst—Method of placing, stowing, and employing life rafts on board ship
3014 A. E. Blavier—A proceeding of conservation of cereals and substances alimentary, vegetable and animal
3015 C. W. Orford—Portable bath
3016 J. Bolvin—Steam engine
3017 C. W. Dixon—Slide valves
3018 D. Kirkaldy—Instrument for ascertaining correct measurements
3019 N. M. Marin—Knapsacks, valises, and other portable cases
3020 I. Evans—Braces
3021 F. H. Gossage—Preparing cotton seeds for the process of decortication
3022 T. W. Webley—Breech loading firearms
3023 W. E. Gedge—Improvements applied to clocks and to the receiving apparatus of telegraphs
3024 J. H. A. Gruson—Railway wheels and tires
3025 W. E. Newton—Machinery for submarine excavations

Dated November 19th, 1866

3026 E. W. Morton—Wheels for carriages and vehicles
3027 S. Glenton—Arrangement of furnace for the consumption of smoke in steam boilers
3028 T. Earp—Improvements in safety cabs and like vehicles
3029 J. Bernard—Motive power engines
3030 A. P. Price—Manufacture of carbonate of soda
3031 T. Wardlaw—Reaping machines
3032 C. H. Simpson—Steam engines and propellers for propelling vessels
3033 J. H. A. Gruson—Armour plating for vessels of war, &c.
3034 T. Greenwood—Construction of lathes
3035 J. H. A. Gruson—Gun carriages and means of working heavy ordnance
3036 W. A. Gibbs—Drying hay and other cut crops
3037 T. Whitley—Combing wool and other fibre
3038 J. L. Clarke—Electric telegraphs
3039 J. Baker—Magnetic engines

Dated November 20th, 1866.

3040 W. Chambers—Stiffening and finishing textile fabrics
3041 T. M. Gladstone—Chains and chain cables
3042 C. D. Abel—Drying tan, and machinery employed for that purpose
3043 G. Haseltine—Construction of hay, manure, and other forks
3044 A. Hunter—Mode of ascertaining the position of such vessels as have foundered at sea
3045 E. Thomas—Safety lamps
3046 R. A. Hardcastle—Raising and lowering heavy bodies
3047 C. E. Brooman—Method of coating iron and steel with copper
3048 J. Robertson—Regulating and controlling the pressure and flow of fluids
3049 J. H. A. Gruson—Breech loading ordnance
3050 J. Howard and E. T. Bousfield—Reaping and mowing machines
3051 J. H. A. Gruson—Manufacture of guns or heavy ordnance of cast metal
3052 E. H. Knight—Improvements in governors

Dated November 21st, 1866.

3053 J. Tasker—Door mats
3054 G. Haseltine—Volute springs
3055 C. J. Wahab—Purifying polluted water
3056 W. Clark—Steam boilers
3057 J. Brindley—Artificial incubator
3058 A. V. Newton—Manufacturing spikes and rivets
3059 G. Haseltine—Attaching casters to the stands of sewing machines
3060 E. Morwood—Coating plates of metal
3061 P. G. B. Westmacott—Conveying, distributing, cleaning, and conditioning corn and grain
3062 J. Barker—Preserving corn or other grain
3063 P. Gledhill—Cutting coal and other minerals

Dated November 22nd, 1866.

3064 J. Nicholson—Safes and other similar depositories, and construction thereof
3065 G. Haseltine—Drilling rocks
3066 P. R. M. Le Guen—Combining tungsten with cast iron by conglomerating reduced wolfram
3067 T. McComas—Raising sunken vessels
3068 R. Holiday—Distance signals on railways
3069 J. Berry, J. B. Turner, and C. Vickerman—Twisting yarns of wool, &c.
3070 R. E. Lazenby—Opening and cleaning fibrous materials
3071 J. H. Johnson—Raising, lowering, moving, or transporting heavy bodies
3072 C. E. Brooman—Iron for ironing
3073 W. R. Lake—Tapping beer casks, and other like vessels containing liquids under pressure
3074 G. F. Stidolph, J. Stidolph, and J. R. Morley—Shop fittings

Dated November 23rd, 1866.

3075 F. Maunder—Preventing the recurrence of periods of excessive speculation and panic
3076 M. Mars—Improved digitorium
3077 J. Kitchen, W. Kitchen, and S. Samuels—Railway break
3078 I. Riley—Links for connecting chain cables and other chains
3079 W. H. P. Gore and R. Green—Constructing and repairing roads, and apparatus employed therefor
3080 W. W. Smith—Fixing the tires of railway wheels
3081 J. Robinson—Economising fuel by retaining and applying heat to the heating of water
3082 J. Robinson—Economising fuel by retaining and applying heat to the heating of water in locomotive boilers
3083 R. Potter—Cleansing, purifying, and bleaching various kinds of grain
3084 J. Coulson—Elevating straw and other produce
3085 F. Tyerman—Shades for shielding the eyes from the glare of strong lights
3086 J. J. Coleman and T. H. Coleman—Hydraulic Cements
3087 T. R. Harding and T. W. Harding—Drilling combs and hackles
3088 F. R. A. Glover—Raising and lowering persons, goods, or articles in dwelling houses and other buildings

Dated November 24th, 1866.

3089 E. Funnell—Electric signals for use on railways
3090 C. W. Siemens—Conveying telegraph despatches, &c., through tubes
3091 C. D. J. Seitz—Bleaching of fibrous substances, and manufacture of bleaching powder, &c.
3092 H. M. Clements—Signals to be used upon railways
3093 J. Mitchell and W. C. Laird—Detergent material applicable to the cleansing of wool, &c., and to all purposes where coarse soap is used.
3094 R. B. Jones—Transmitting and recording messages or signals
3095 W. Bess—Making of nails, &c.
3096 W. B. Johnson—Arranging and driving the shafting of loom sheds
3097 J. K. Leather—Salts of soda and potash
3098 G. Haseltine—Looms for manufacturing pile fabrics
3099 C. H. Southall, R. Heap, and J. Tasker—Uniting together two or more strips of leather or other material to be used as machine belts, &c.
3100 W. Botwood—Raising and lowering the heads of carriages
3101 C. Wood—Measuring the temperature of currents of air or fluid

Dated November 26th, 1866.

3102 J. Buckley—Preparing and spinning cotton or other fibrous substances
3103 W. E. Gedge—Manufacturing wadding
3104 W. E. Gedge—Evaporating the juices of various substances
3105 W. R. M. Thomson—Cutting iron and other metallic tubes or pipes and machines for that and to some extent other analogous purposes
3106 W. E. Newton—Extracting oil and paraffine from bituminous substances
3107 J. E. Boyd—Grass mowing machines
3108 G. H. Morgan and E. Morgan—Carriages
3109 W. Taylor—Treatment of jute, &c., and apparatus employed therein
3110 W. H. Harrison—Producing optical illusions for dramatic and other like exhibitions
3111 T. J. Barron—Converting iron into steel by the action of certain gases, and producing gases for such purpose
3112 N. S. Shaler—Preserving animal and vegetable substances
3113 R. H. Courtenay—Preparation of printing surfaces by the aid of photography
3114 W. Clark—Preparation of leather, &c.

Dated November 27th, 1866.

3115 J. H. Johnson—Woollen and other yarn, and treating the same
3116 A. Fournet and O. Nadaud—A magic camera
3117 C. Cruckford—Manufacture of spelter, &c.
3118 C. Crockford—Obtaining useful products from certain materials produced in coating iron with zinc
3119 J. Kerfoot—Mules for spinning and doubling cotton and other fibrous substances
3120 J. H. Atterbury and S. Woolf—Earthenware and other plastic materials
3121 J. Law—Carding wool, &c.
3122 T. Dickins, H. Heywood, and J. Holland—Furnaces and steam boilers
3123 A. V. Newton—Making cast steel railway wheels, &c.
3124 W. Clark—Means for indicating the time and distance travelled by vehicles
3125 R. George—Obtaining motive power
3126 J. Tomlin and C. Hook—Manufacture of gas and preparation of fuel

Dated November 28th, 1866.

3127 G. Backhouse—Manufacturing cardboard or pasteboard
3128 R. Norfolk—Reaping machines, &c.
3129 H. Timms—Furniture springs, and machinery to be employed therein
3130 W. Clark—Impermeable mastic compositions, and their application
3131 W. Pidding—Treating coffee and tea for general uses
3132 H. Longsford—Harness, saddle, and tugs
3133 W. R. Lake—White lead
3134 G. Haseltine—Regulating and registering the tension of pianoforte strings
3135 G. Howard—Elastic seat
3136 L. A. Fargon—Forming the points of iron and other tubes

Dated November 29th, 1866.

3137 J. Wadsworth—Rendering the soles and heels of boots, shoes, and clogs more durable, &c.
3138 G. Crossley—Driving wire blocks
3139 E. Hughes—Exhausting and forcing air and gases, &c.
3140 T. W. Plum—Drawing off beer, &c., from casks and other vessels
3141 R. Mitchell—Revolving watch bow and pendant
3142 E. V. L. Ebersburg—Milk for feeding infants and invalids
3143 J. Field—Steam engines
3144 F. La Moile—Rearing young chickens
3145 W. Brookes—Railway wheels called disc wheels

Dated November 30th, 1866.

3146 E. T. Hughes—Saccharification of sugary substances
3147 T. Petitjean—Method of combustion
3148 E. E. Quelle—Muffs
3149 H. Bateman—Pumps and fire engines
3150 W. W. Pilcher—Horse shoes
3151 L. Turner—Elastic fabrics
3152 W. Clark—Green colouring matters
3153 A. Davy—Chair supports for the rails of railways
3154 H. P. Truefitt—Hair, nail, tooth, and flesh brushes

Dated December 1st, 1866.

3155 P. McGregor—Spinning and doubling
3156 J. Webster—Lighting, heating, and cooking apparatus
3157 W. Crighton—Preparation and manufacture of cotton, &c.
3158 J. Ramsbottom—Compound steam engines and steam generating furnaces
3159 W. E. Newton—Untwisting, opening, and carding all kinds of rope and cordage
3160 G. Mansell—Lettered tablets, &c.
3161 W. E. Newton—Rolls of spinning, drawing, and other machines
3162 H. Bateman—Corkscrews
3163 J. Pratt—Writing with type
3164 W. Butler and A. Dalgety—Connections between railway engines and carriages
3165 S. J. Browning—Distilling sea water

Dated December 3rd, 1866.

3166 T. Barker—Delivery of fog signals upon railways
3167 J. Nuttall—Looms for weaving
3168 F. Waddington—Doubling slivers of cords, &c.
3169 M. A. F. Mennons—Automatical performance of music on pianos, &c.
3170 H. A. Dufrené—Chimney
3171 J. T. A. Mallet—Producing jointly or separately oxygen and chlorine with a same chemical substance and in the same apparatus
3172 E. McLean—Pianofortes and harmoniums
3173 W. Clark—Applying and regulating motive power
3174 B. J. B. Mills—Bench vices
3175 F. Volkmann—Ploughs
3176 A. Herman and H. Brethauer—Discharging bilge water from vessels' holds
3177 D. Winstanley—Obtaining basso relievo or other such designs in relief, &c.
3178 W. H. Hatfield—Chain cable holders
3179 J. A. Coffey—Heating and cooling fluids

Dated December 4th, 1866.

3180 H. A. Bonneville—Manufacture of white lead and vessels connected therewith
3181 J. Horton—Producing metallic pipes, tubes, or other similar hollow articles
3182 J. Smecton—Signalling apparatus for railway trains
3183 T. Wilson—Cartridges for breech loading firearms
3184 J. Broadbent—Weft forks
3185 E. Saug—Sewing machines
3186 G. Haseltine—Mowing and reaping machines
3187 F. Kohn—Cutting sugar cane
3188 D. S. Chater—Prevention of smoky chimneys

Fig. 1. TRANSVERSE SECTION.

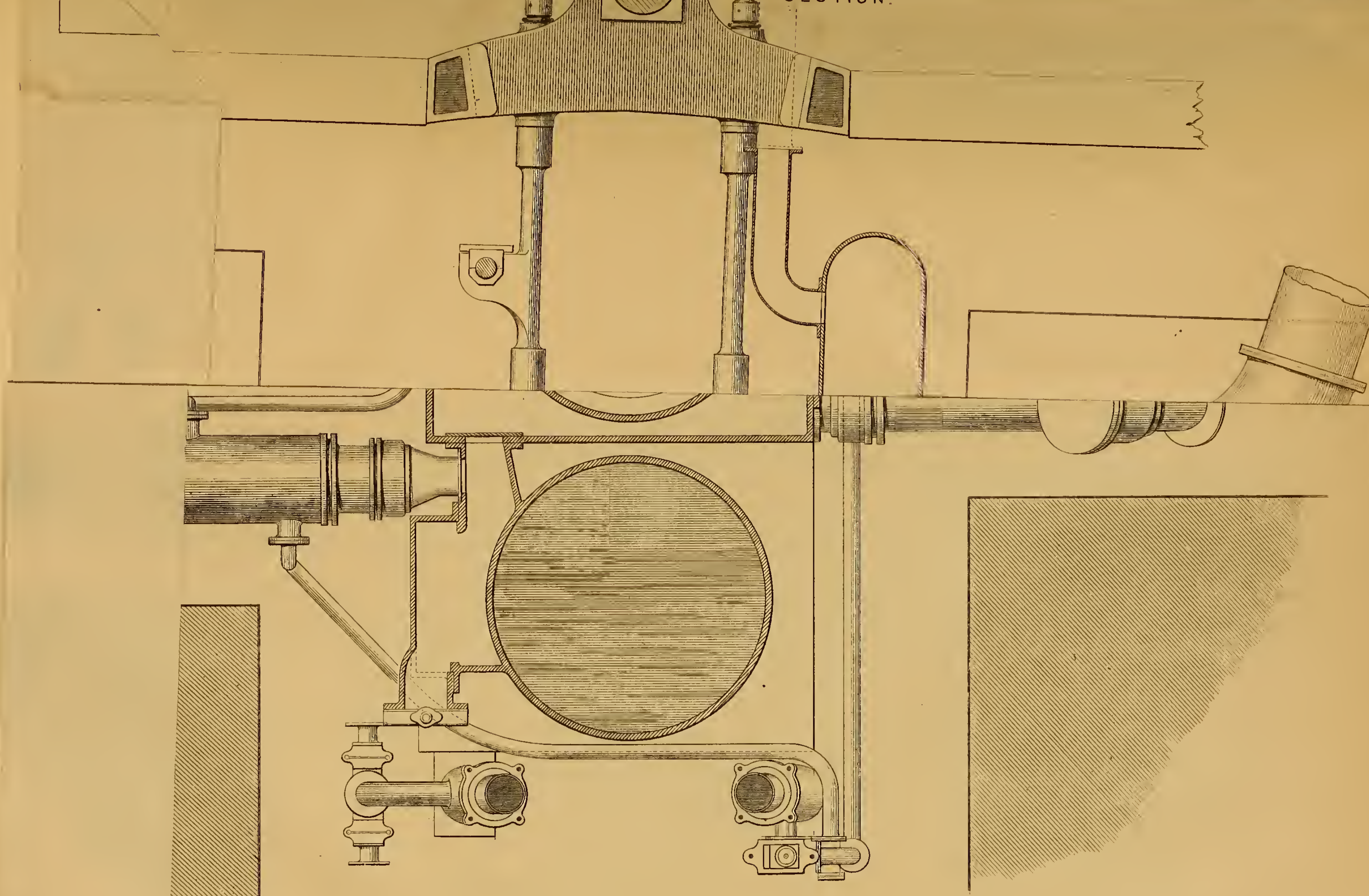
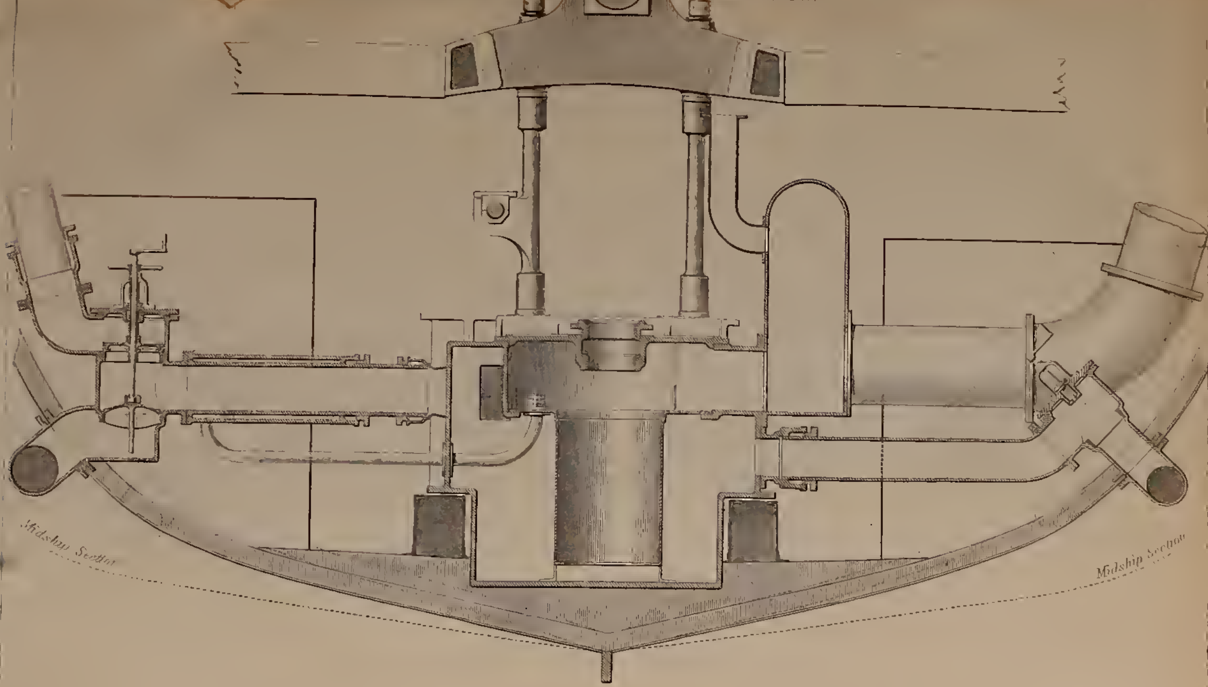


Fig. 2. SECTIONAL PLAN

Scale of Feet

FIG. I. TRANSVERSE SECTION



ENGINES OF THE SCREW STEAM SHIP "BITTERN."

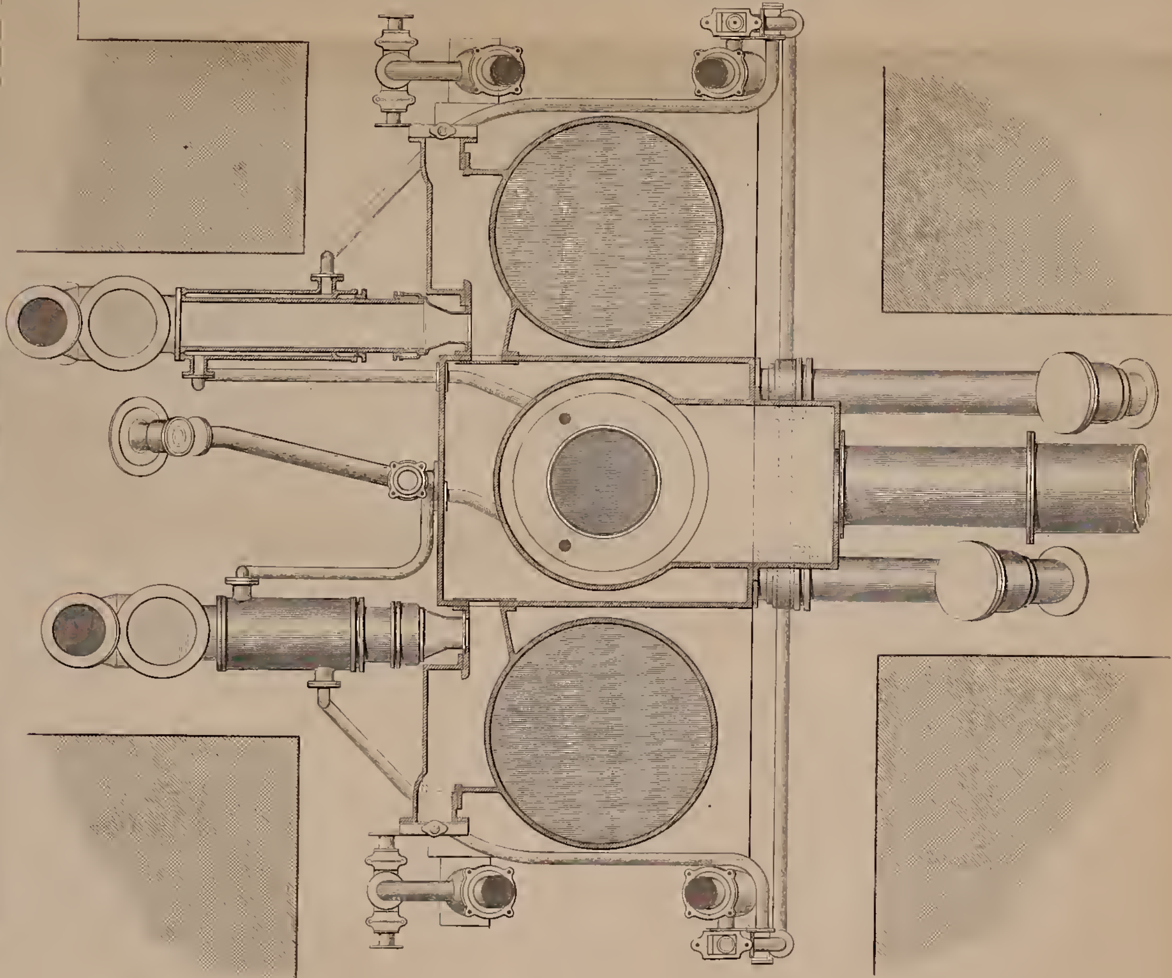


FIG 2. SECTIONAL PLAN

Scale of Feet

W. Smith & E. Dwyer

THE ARTIZAN.

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1st FEBRUARY, 1867.

THE SCREW STEAMSHIP "BITTERN."

(*Illustrated by Plates* 309 *and* 310.*)

The great importance to a commercial steamship company, more especially, of fuel economy in the management and working of a steam fleet is understood and admitted, and every intelligent superintendent engineer of a steamship company is fully alive to the necessity for practically tackling the question in each case, in accordance with his own views, or as he may consider best adapted to the particular requirements of the service with which he is connected.

It is now a well-known fact, in the application of a superheater to a marine steam boiler that, generally, the worse the boiler the better result obtained through the application; indeed, the addition of a superheater to do what the boiler in its original state did not do, but if it had been properly designed ought to have done, is like all other kinds of patching and mending, but a remedial apology for an imperfect condition of things; this is only to be avoided, as we have for many years past pointed out, by higher scientific skill, and the application of observed results of past experience being conjointly brought to bear on the designing of steam boilers; always the least inviting and seductive part of steam engineering.

Surface condensers and surface condensation—matters more attractive to the ingenious practical mechanic and the marine engineer more particularly—have had their fair share of attention bestowed on them during the last fifteen years or so, and the mere attempt to give a list of the patents granted in England for such contrivances would well-nigh fill a third part of a number of The Artizan; but the importance of the application of a really effective surface condensation to ocean-going steamers is not underrated amongst engineers, and although numerous failures in the application have occurred in practice, as steamship owners well know, the latter are generally willing to risk much to secure the attainment of a real and continuous economy in the development and use of steam power.

Boxes of brass or copper tubes ingeniously varied in every conceivable kind of way to meet the fancy of the designer, have performed their function of condensing the exhaust steam by the aid of cold salt water applied to the opposite side of the metal surfaces, and the cooling down of the fresh water of the condensed steam from water originally more or less salt when in the boiler, have been found to involve a destructive action upon the boiler-plates, tubes, and other parts of the steam-generating and utilising apparatus of the ship; and when iron-surface condensers and their connections are adhered to and adopted of suitable proportions and construction, they are preferred, although tinning all the surfaces of brass and copper condensers has been found to prevent the destructive action complained of.

The superintending engineer of the Cork Steamship Company, Mr. Alexander Crichton, has for several years conducted a series of useful experiments upon the various practical details of steamship management and economy, and boiler construction and surface condensation have been amongst the subjects under his investigation.

Some experiments undertaken by Mr. Crichton, nearly twelve months ago, upon a small steam screw yacht, induced him to substitute for the box-shaped surface condenser some iron pipes or tubes placed under the ship's bottom, on each side of the keel, the one end of each pipe being connected with the exhaust of each engine; the other end being also carried in-board was connected with the air pump. The results obtained by Mr. Crichton were so satisfactory as compared with those of other condensing apparatus he had used, that he was induced to propose to his directors to alter the engines, boilers, and machinery of the screw steamer *Bittern*. The proposition having been accepted was acted upon, and the *Bittern* was laid up for the purpose, and the alterations were carried out by Mr. Crichton without loss of time. The old boilers being in bad condition, were replaced by new ones, and are loaded to work at 20lbs. per square inch, instead of 15lbs., the previous working pressure. Instead of using the old injection condenser, cover plates were put over the former openings connecting the condenser with the exhaust of each engine and a short junction pipe, forming a feed-water-heater, was introduced between the exhaust of each engine and the ship's side. Here a compound shut-off valve was introduced by which the steam could be either turned into the external condensing pipes, or discharged above the deck line; or, in case of accident to the surface condenser, the pipes in connection, or the shut-off valves, the cover plate of the old injection condenser could be at once removed, and the injection condensation employed as before. Beyond the shut-off valve of each engine the condensing pipe extends outside the ship, so as to be below the greatest breadth, and out of harm's way. The condensing pipe of each engine was made to pass along the one side round the stern, through the screw opening, and along the other side of the ship in-board to the foot of the air-pump. Mr. Crichton found in the course of his experiments in the use of external condensing-pipes that thin wrought-iron condensing-pipes, carefully galvanised inside and outside, were better than cast-iron pipes, which he first used of 10ins. bore and $\frac{3}{8}$in. thick, and then substituted two wrought-iron pipes along each side of the ship, each 7ins. diameter, and $\frac{5}{16}$ins. thick, connected together at each end fore and aft with a single breeches pipe, each length of double pipes belonging to each engine being free to expand and contract at the stern of the ship, whilst the pipes are held in their places and secured to the ship's sides by bands.

The main parts of the engines, which are vertical trunk engines geared to speed the screw, are generally the same as before. The air-pump, however, is reduced to one-half of its former area, and an air-pipe of six inches diameter has been fitted to the hot well, to allow the air pumped out of the condensed fresh water to escape without lifting the discharge valve at the ship's side.

When the *Bittern* was again completed for service she was put upon the same station, and subjected to a series of trials, of which correct records were taken similar to those previously kept of her performances, and the extent of the improvements effected by the alterations carried out by Mr. Crichton were so satisfactory as to be well worthy of record.

Comparing the results, the economy and other advantages obtained since the introduction of the surface condenser by Mr. Crichton are so self-evident, that it only remains to point out that whilst some portion of the improved results doubtless arose from the use of the new boilers, the proportion due thereto can, without difficulty, be readily separated from the other elements, the materials for the calculation being given.

It will be observed that the coal consumption per hour is now less than formerly, although the speed of the ship is greater, whilst the coal consumed per indicated horse power per hour shows a considerable reduction in quantity. No doubt a large proportion of this economy is through the boilers now being fed with fresh water of low density not necessitating the "blowing off" to preserve the boilers free from scale and salt incrustation; and, on examining the interior of the boiler none of those well known signs of galvanic action and corrosion which takes place when

* Plate No. 310 will be given in our next.—Ed. "Artizan."

brass tubes or sheet surface condensers are used could be found, nor is it possible for such action to occur.

The following particulars and abstracts from the log of the ship will more readily convey what we consider the advantages of Mr. Crichton's improvements:—

Comparative performance of Cork Steamship Company's vessel, "Bittern," fitted with common injection condenser, and with A. Crichton's surface condenser during two voyages from Cork to Cardiff and back.

——	With Common Condenser.	With Surface Condenser.
Tonnage, gross	664 tons	664 tons
Horses-power, nominal	110 horse-power	110 horse-power
Diameter of Cylinders (deducting area of trunk)	= 43 inches	= 43 inches
Length of stroke	33 inches	33 inches
Revolutions per minute	40 revolutions	46 revls.
Pressure of steam on safety valves	15 lbs.	20 lbs.
Vacuum per gauge	25 inches	27 inches
Indicated pressure of steam (Mean of both engines on piston throughout top and bottom stroke)	8.05 lbs.	10.75 lbs.
Indicated vacuum (Mean of both engines on piston throughout top and bottom stroke)	10.2 lbs.	11.00 lbs.
Indicated horses-power	358 horse-power	484 horse-power
Ratio of indicated to nominal horse-power	3.25 to 1	4.4 to 1
Condensing surface per nominal horse-power	—	5.85 sq. ft.
Area of fire grate	84.5 sq. ft.	80.25 sq. ft.
Mean speed of Vessel per hour	8.75 knots	9.6 knots
Mean consumption of coals per hour	13.3 cwt.	12.7 cwt.
Mean consumption of coals per hour per indicated horse-power	3.89 lbs.	2.81 lbs.
Mean density of water in boilers	$\frac{1\frac{3}{4}}{32}$	$\frac{1}{32}$
Diameter of screw	11ft. 9in.	11ft. 9in.
Pitch of screw	10ft. 9in.	10ft. 9in.
Revolutions per minute	86.6 revls.	99.6 revls.

The speed of the ship, it will be seen, notwithstanding the addition of the exterior pipes, has been considerably improved consequent upon the larger power now given out by the engines, owing to the higher pressure of steam, the increase of effective vacuum, and the reduction of engine power required to work the air-pump, now only of half the former area.

Although Mr. Crichton has departed from the usual proportion of condensing surface per normal horse power, yet he appears to have given amply sufficient in the present case, judging by the amount of vacuum obtained, and which we are informed is more constant or steady at the amount recorded than the vacuum of the old injection condenser, although the latter was never so high or effective. Moreover, on taking the temperature of the return condensing pipe inward it was not found to exceed 100° at any time.

Having looked carefully into the recorded performances of the *Bittern*, during a series of voyages, both before and since the alterations in her engines and machinery made by Mr. Crichton, we have thought them of sufficient interest to lay the results before the readers of The Artizan, accompanied by two sheets of copper-plate illustrations, to convey more accurately than can otherwise be done, the mode in which Mr. Crichton has carried out his improvements. In Plate No. 309, fig. 1, is a transverse section of the ship and engines, and fig. 2 is a sectional plan. In Plate No. 310, a side elevation of the ship shows the arrangement and disposition of the surface condensing tubes. As we are unable to give the detail textual description of the several parts of the various figures in Plates 309 and 310, in our present number, we propose to defer them until our next, when we expect to be in a position to furnish some additional particulars concerning the *Bittern's* performances.

ON VAST SINKINGS OF LAND ON THE NORTHERLY AND WESTERLY COASTS OF FRANCE AND SOUTH WESTERN COAST OF ENGLAND, WITHIN THE HISTORICAL PERIOD.

By R. A. Peacock, Jersey.

(*Continued from page* 6).

Cæsar mentions that he sent Sergius Galba with the twelfth legion, "because he willed that a passage should be laid open through the Alps, by which passage merchants had been accustomed to go with great danger and great tolls."*

133. *Which was the Isle of Ictis?*—Certain eminent authorities are of opinion that the geographical change which has occurred since St. Michael's Mount was "the hoar rock in the wood," cannot have taken place within the last 2,000 years, because, as it has been alleged, this was the island referred to by Diodorus, who wrote before Christ, when he spoke of the Britains carrying the tin into an island situate before Britain, called Ictis.† If St. Michael's Mount was not Ictis, I know of no other competitor, unless it be Wolf Rock. The Rev. W. Borlase, F.R.S., and Sir Henry de la Beche (Report on Cornwall, &c., p. 418), both give us reason to believe that there have been great losses of land within historical times, and the latter adds—"Of the great loss of this land within modern times Dr. Boase adduces ample proof," to say nothing of Camden, and his tradition of the lost country of the Lionesse. One part of the question is, do not the submarine trees of the Rev. Mr. Borlase (and of others to be specified hereafter), by their comparative freshness, indicate a comparatively modern submersion, like the submarine trees of the Channel Islands, or in the Bay of Mont S. Michel?

Let us hear the Rev. Mr. Borlase. The Rev. William Borlase, F.R.S., read a paper which is published in the "Transactions of the Royal Society," for 1757, p. 80:—"*Of some trees discovered underground on the shore at Mount's Bay, in Cornwall.*" In the said place one day, Mr. B. found the roots of a tree branching off from the trunk in all directions, and on further search, about 30ft. to the west, he found the roots of another tree, but without any trunk, "though displayed in the same horizontal manner as the first. 50ft. further to the north, was the body of an oak, 3ft. in diameter, reclining to the east. On digging about it, it was traced 6ft deep under the surface; but its roots were still deeper than they could pursue them. Within a few feet distance was the body of a willow, 1½ft. diameter, with the bark on; and one piece of a large hazel branch, with its bark on. What the first two trees were it was not easy to distinguish, there not being a sufficiency remaining of the first, and nothing but roots of the second, both pierced with the teredo, or augur worm. Round these trees was sand about 10in. deep, and then the natural earth in which these trees had formerly flourished. It was a black marsh earth, in which the leaves of the juncus were entirely preserved from putrefaction. These trees were 300yds. within full sea mark; and when the tide is in, have at least 12ft. of water above them. But these are sufficient to confirm the ancient tradition of these parts, that St. Michael's Mount, now enclosed half a mile with the sea when the tide is in, stood formerly in a wood.‡ That the wood consisted of oak, very large, hazel and willow trees is beyond dispute. That there has been a subsidence of the sea shores thereabouts, is hinted in a former letter; § and the different levels and tendencies observed in the positions of the trees found, afford some material inferences as to the degree and inequalities of such subsidencies in general (?); as to the age in which this subsidence happened (it is) near 1,000 years since at least." In Milner's "Gallery of Nature," p. 387, it is stated that in the time of Edward the Confessor, the rock of St. Michael's Mount was the site of a monastery described as being *near* the sea; and as the storm

* *De bello Gallico.* Lib. III., c. 1.

† "Hardwicke's Report of the Birmingham Meeting," p. 126; and Brit. Ass. Report 1856, p. 71; Trans. of Sections.

‡ See Camden's "Britannia."

§ This refers to another paper of Mr. Borlase's, for 1753, p. 324, vol. X., "Phil. Trans, R.S.," in which he says the Scilly Isles *were* ten in number (as Strabo states, Book III., chap. v., sec. 11), but *are now* 140; and where he thinks that for various reasons stated there must also have been a subsidence.

of 1099, mentioned in the Saxon Chronicles, occurred in the autumn,* the submersion of the district has been referred to in that inundation, he says: Vice-Admiral Thevenard in "Mem. relatifs à la Marine," 4 vols., 8vo., An. 8, (A.D. 1800), Vol. II., p. 13, mentions, "la submersion du terrain * * et de la pointe ouest de l'Angleterre * * *au commencement du IX siècle.*" The italics are mine.

I have read, with great interest, the large mass of important and well-condensed facts, by Mr. Pengelly, F.G.S., F.R.S., entitled "Changes of level of Devonshire." It was read at the Bath meeting of the British Association, and is in the *Reader*, of Nov. 19th, 1864, which (thanks to Mr. Pengelly) is now before me, in extenso, corrected by the author. The conclusions he arrives at are (amongst many other interesting things which do not concern the present purpose) that after many subsidences and elevations, "since the last adjustment, the coast line of south-eastern Devonshire has everywhere retreated." And "even in some of the limestone districts, every ebb tide exposes a broad platform of denudation; and in the new red sandstone localities the waves, which at spring tide high water assail the cliffs, break at low water nearly half a mile from them, and thus furnish a rude measure of the minimum of time which has elapsed since the completion of that downward movement which submerged the forests.† I have no personal knowledge of the locality, and very willingly accept this statement, which plainly proves that the latest sinking there, of which we have certain knowledge, was *long before the historical period* (and, therefore, is beyond the limits, which are dealt with in these papers), because the broad platform of limestone denudation must have taken many ages to produce, as also must the cutting back for half a mile in the new red sandstone districts. I make this general reservation, however, which cannot be too much insisted on, that bones or horns of extinct animals and every other species of pre-historic relic, though it may have been deposited either at the sea bottom or on dry land in pre-historic times, and may have been elevated or depressed with the land again and again also in pre-historic times, yet for all that, while it still lay in situ and not yet discovered by the geologist, there *may have been*, also, one or more risings or sinkings completely within the historical period, in which it partook.

Referring to Mr. Borlase's date of "near 1,000 years since at least," that number deducted from 1757 (the date of his paper) gives A.D. 757, which, observe, is less than half a century later than the great subsidence of 709 on the other side of the English Channel, which we have been considering. And at any rate it is clear that Mr. Borlase's opinion was, that the subsidence had taken place within the Christian period. If, instead of using the *round number* 1,000, he had happened to say 1,048, we should then have had the exact date 709,—the year of the great catastrophe about Mont S. Michel. The trees in Mount's Bay were *so fresh* that the species of several were clearly identified, as we have seen; which circumstance is, of itself, a strong argument in proof of their recent submersion.

Dr. Gibson, the editor of Camden's "Britannia," says that St. Michaels' Mount is called *Careg cowse in clowse*, in Cornish, which means, he says, "the hoary rock in the wood." *Careg* is doubtless the origin of the English word *crag;* and *cowse* is said to mean *cana*, white; and *clowse* obviously means a *close* or enclosure. Mr. Metivier says that St. Michael's Mount was *Carreg Coedh yn clôs*, rock of the wood in the enclosure.

134. *Which islands did Diodorus refer to?* If "the storm" of 1099, that at the commencement of the ninth century (both accompanied by submersions of land), or Mr. Borlase's submersion in the eighth century, are any of them true,—and there does not appear to be reason to doubt the truth of any of them,—then it would follow, that Saint Michael's Mount cannot have been the ancient Isle of Ictis, because, must we not suppose that the mount only became an island at one of those submersions? In that case we must look to Wolf Rock, Seven Stones, or to some island now totally lost, for that ancient island, Wolf Rock, may have been the ancient Ictis, if there be any foundation for Camden's well-known tradition of the Lyonesse country. Cornwall, it is very likely, once extended farther west and north-west; and if that was so, Wolf Rock would have been "opposite Britain," as Diodorus says the Isle of Ictis was. The question of the identity of Ictis will be further considered in chapter xvi.

Diodorus calls his islands "neighbouring" islands (πλησίον νήσους) as if they were islands lying neighbouring to Cornwall, of which he is speaking. But, on the other hand, he says they were islands "in the middle between," (τὰς μεταξὺ κειμένας) Europe and Britain.

Does he mean first, to limit his meaning to the coast of Cornwall? Or second, does he include all the islands lying neighbouring to the south coast of Britain? Or, thirdly, does he mean the Channel Islands, Guernsey, Sercq, Herm, and Alderney, which are geographically, "the islands lying between Europe and Britain?" We will consider each of these three questions in order.

Ictis was no doubt near the then coast; if it had been so distant that the distance was worth remarking upon for its magnitude, the miners would not have been likely to have carted the tin into the island in such abundance, because the distance would have been too great; and we have no historical authority for believing that there was any other isle than Ictis off the coast of Cornwall, and in that case he would not have used the plural number, and said islands. But more than all, it would have been particularly absurd to describe an island lying near the coast of Cornwall, as "between Europe and Britain," when the whole distance across from Europe (Britanny) to Britain is a hundred miles. We may not impute such an instance of clumsy description to such a man as Diodorus. If he had meant an island or islands near the south coast of Britain, he would doubtless have said so, and never have mentioned Europe at all. If he had meant to include the so-called Isle of Portland and the Isle of Wight, along with Ictis, he would also (if we are to give him credit for common sense) have said "islands near the south coast of Britain," without mentioning Europe at all. He would no more have named Europe than we should say, in describing the position of Ireland, that "it lies between America and Britain," or in geographically describing Waterloo Bridge, that "it lies between the English Channel and the Strand." The reader would not commit either of these two absurdities, and can have no right to impute anything of the sort to such a man as Diodorus. And, secondly, we have no authority for supposing that Portland was other than it is now, namely a peninsula connected to the mainland by Chesil Bank; or that Wight was other than it is now, namely, an island at all times of tide.* And even if we beg the question that the two spaces were then alternally wet and dry (which they certainly are not now) we should still be in the dilemma that the distances (two or three miles each) are too small to have been worth special remark as anything "peculiar." For there must have been hundreds of well-known cases where spaces, as great as those, were alternately wet and dry.

I believe the following is the true interpretation of Diodorus's remarkable passage, and it makes everything perfectly clear and reasonable. If we suppose, as some contend, that μεταξὺ only means "between;" still when we say that anything lies between two other things, we usually mean that it is at or near the *middle;* and thus Guernsey, Sercq, and Alderney, are about half way from Britain to Britanny, and must be the islands meant. Much more certainly must Diodorus have meant those islands, if we say with Liddle and Scott that μεταξὺ means *in the middle.* For in that case most certainly the northern Channel Islands were meant. The present space between Guernsey and the Continent is twenty-seven miles; and if anything like that extent had been dried at low water, it would have been very "peculiar" and well worthy of being recorded. I think they are called "neighbouring" islands to distinguish them from the *remote* islands in the Bay of Biscay, which are also in a certain sense between Europe and Britain, and mention of them was doubtless suggested to Diodorus's mind by the circumstances

* We are not bound to suppose that the sinkings took place in *autumn*, merely because nuts are found; nut shells will take years to decay, especially if slightly covered with leaves, &c.

† Page 645.

* Suetonius and others will be quoted hereafter to prove that Vectis (Wight) was an island at various early periods in the Christian era.

of the space between the northern Channel Islands and the Continent *being dry at low water,* like the space between Cornwall and Ictis; and by the other circumstance of the tin being carried past them into Gaul.

135. *Objections answered.* The suggestion of a friend that Diodorus probably alluded to the Scilly Isles, and that Ictis was one of them, is at once upset by the fact that the Scilly Isles are *not* between Europe and Britain. There is also a sounding of as much as forty-eight fathoms between the Land's End and the Scilly Isles; if the intermediate space was once dry land, a greater sinking is implied than I contend for, and Camden's tradition of the Lyonesse country would be realised. Another friend makes the following objections which are given in his own words, he says: "The neighbouring islands lying between Europe and Britain, mean only Mont S. Michel, Portland, and the Isle of Wight," and do not include the Channel Islands, and he relies particularly on the word γαρ (for) in the previous sentence* as connecting it with what has previously been said about the Isle of Wight.† He thinks there have been partial sinkings near Mont S. Michel and elsewhere, but not to any considerable extent, and that the fact of the Channel Islands not being sufficiently important accounts for the non-mention of them.

His contention in favour of Portland and Wight being Diodorus's islands have already been answered; and with respect to Mont S. Michel, the space between it and the Continent was the Forest of Sciscy, and not sea, until seven centuries and a half after Diodorus's time, as we have already proved.

(*To be Continued*).

* "For the middle space being dried by the ebb, they carry the tin into this (island) in abundance.
† Ictis does not mean the Isle of Wight, as my friend here supposes.

MINING STATISTICS OF GREAT BRITAIN, 1856-65.

According to a return prepared by the Government Inspector of South Durham, it appears that the deaths from explosions of fire-damp in Great Britain in the ten years, 1856 to 1865, were 2,019. Out of this number 412 occurred in South Wales, 340 in Yorkshire, 238 in North and East Lancashire, and 126 in South Staffordshire and Worcestershire. The total number of explosions from fire-damp in Great Britain was 235 in 1856, and 377, 215, 95, 363, 119, 190, 163, 94, and 168 successively in the nine following years. The deaths from falls in Great Britain in the same period (1856-65) amounted to 3,953, 745 of which occurred in South Staffordshire and Worcestershire, 530 in South Wales, 358 in West Lancashire and North Wales, and 238 in Yorshire. In the ten years, the number of deaths from accidents in shafts was 1,710, and from miscellaneous causes on the surface of the earth, and in mines 2,234. The total number of deaths from all violent causes in the ten years was 9,916. Out of this number 1,357 occurred in South Wales, 1,302 in South Staffordshire and Worcestershire; 1,141 in Northumberland, Cumberland, and North Durham; 976 in West Lancashire and North Wales; and 787 in Yorkshire. In 1856, 1,022 deaths occurred from all violent causes in Great Britain, and 1,122, 931, 905, 1,109, 936, 1,133, 907, 867, and 984 successively in the nine following years. Of the 9,916 deaths, 2,019, or 20 per cent. were from fire-damp explosions; 3,953, or 40 per cent., were from falls of roof and coal; 1,710, or 17 per cent., were shaft accidents; and 2,234, or 23 per cent., were miscellaneous accidents in mines and above ground. In the last two years (1864 and 1865) the returns for Great Britain show a reduction of 991 deaths in proportion to the increased quantity of coal raised, or nearly 35 per cent., as compared with the fatality in the two years 1856 and 1857. In the five years, 1856 to 1860, there were 5,089 deaths from colliery accidents in Great Britain, and during the same period 381,067,047 tons of coal were raised. In the succeeding five years, 1861 to 1865, 468,548,905 tons of coal were raised, so that if the deaths had increased in the same proportion as the quantity of coal raised, the deaths in the latter quinquenniad would have been 6,257 whereas they only amounted to 4,827, being 1,430 less than in the former quinquenniad. This shows a reduction of fatalities to the extent of 23 per cent. in five years, being at the rate of 46 per cent. per annum in relation to the coal raised. In the three years immediately succeeding the passing of the Duplicate Shaft Act (1862) the deaths in Great Britain were 690 less in proportion to the quantity of coal raised than they were in the three years immediately preceding the passing of the act. In 1856 the number of tons of coal raised in Great Britain was 71,787,552; in 1865 it was 98,911,169. Taking the several groups of inspection districts into which the coalfields of the country are divided, the return shows the following results for 1865:—To one death the number of miners employed was 182 in South Wales; 238 in West Lancashire and North Wales; 258 in Northumberland, Cumberland, and North Durham; 296 in South Staffordshire and Worcestershire; 325 in Monmouthshire, Gloucestershire, Somersetshire, and Devonshire; 330 in Derbyshire, Nottinghamshire, Leicestershire, and Warwickshire; 340 in the western districts of Scotland; 356 in North and East Lancashire; 403 in North Staffordshire, Shropshire, and Cheshire; 414 in South Durham; 450 in the eastern districts of Scotland; and 636 in Yorkshire.

THE COMPOSITION, VALUE, AND UTILISATION OF TOWN SEWAGE.

(*Continued from page 278, ser. III., vol. 24.*)

TABLE XI.

Detailed Composition of samples of the Rugby Sewage before application, and of the Drainage-water from the irrigated land, collected July, 1864.

	Constituents.	Grains per Gallon. Collected July 6—11. Sewage.	Drainage.	Collected July 13—18. Sewage.	Drainage.
In suspension.	Inorganic matter:—				
	Oxide of iron and alumina ...	4·57	...	6·30	...
	Lime ...	4·48	...	3·75	...
	Magnesia ...	0·65	...	0·25	...
	Carbonic acid...	3·25	...	2·17	...
	Phosphoric acid...	1·84	...	1·14	...
	Silica, sand, &c. ...	31·60	...	39·30	...
	Total ...	46·39	...	52·91	...
	Organic matter ...	40·40	...	32·40	...
	Total matter in suspension	86·79	...	85·31	...
In solution.	Inorganic matter:—				
	Oxide of iron, &c. ...	Traces.	...	1·25	0·25
	Lime ...	8·45	10·25	8·23	10·08
	Magnesia ...	1·76	1·69	1·80	1·69
	Soda (1) ...	5·46	0·38	5·24	2·30
	Chloride of Sodium (1)...	6·82	9·73	8·53	9·21
	Chloride of potassium (1) ...	6·08	1·50	6·17	2·34
	Sulphuric acid ...	4·39	6·55	4·01	6·75
	Phosphoric acid...	1·28	0·44	1·66	0·32
	Carbonic acid...	8·83	6·18	7·42	7·01
	Silica ...	1·80	0·80	1·00	0·80
	Total ...	44·87	37·52	45·31	40·75
	Organic matter ...	11·20	7·80	10·00	7·05
	Total matter in solution ...	56·07	45·32	55·31	47·80
	Total inorganic matter...	91·26	37·52	98·22	40·75
	Total organic matter (2) ...	51·60	7·80	42·40	7·05
	Total solid matter...	142·86	45·32	140·62	47·80
(1) Containing	Potassa ...	3·84	0·94	3·90	1·48
	Soda ...	9·07	5·54	9·76	7·17
	Chlorine ...	7·03	6·61	8·10	6·70
(2) Containing	Ammonia: In suspension ...	2·92	...	2·42	...
	Ammonia: In solution...	5·74	0·98	6·36	0·92
	Ammonia: Total ...	8·66	0·98	8·78	0·92
	Nitric acid in solution = Ammonia ...	......	(3) 1·33	...	(4) 1·41

(3) 4·227 Nitric acid = 1·096 Nitrogen = 1·331 Ammonia.
(4) 4·183 „ = 1.162 „ = 1·411 „

Tho soil was light and gravelly, with a gravelly subsoil; but an examination of tho figures in Tablo XI. shows, that it had douo the work of absorption, at any rato as well as, if not bettor than, on tho avorage, did the soils in tho othor fields. It was intonded to take samples for dotailed analysis from this field under various conditions of tho weather, bnt owing to the continuance of the drought, this could not bo accomplished.

In judging of those results, as well as those alroady considered, it must, of course, bo borne in mind that, excepting whon tho land is already saturated with wator, a gallon of drainago will reprosont much more than a gallon of sewago; and that, hence, the amount of any constituent of the sewago found iu a gallon of tho drainage, must have been derived from more than a gallon of the former. Tho non-retention of valuablo manurial matters by the soil was, therefore, not so great as would at first sight appear on an inspection of the comparative composition of equal volumes of the sewage and of the drainage.

As in the larger number of cases, so in these, the quantity of matter in suspension in the drainage was very small, and being obviously in great part derived from tho soil, it was not submitted to quantitative analysis, A considerable proportion of the phosphoric acid of tho sewage was in suspension, but thore was none of it in suspension in the draiuage, the whole of the portion so existing in tho sewage having boen retained by the soil.

It is satisfactory to observe that among tho inorganic constituents in solution in the sewage, by far the larger proportion of thoso which are, perhaps, tho most likoly to bocome relatively deficient, was retaiued by the soil. Thus, smaller proportions of both the potassa and the phosphoric acid of the sewago passed off in tho drainage than of any other constituents. Soda was also retained by the soil to a considorable extent, magnesia in a less degree and lime less still. Of limo, indeed, there was more in a gallon of drainage than in a gallon of sewage; of sulphuric acid also there was considerably more in the drainage than in an equal volume of the sewago. Lastly, of soluble silica a noteablo portion passed off in the drainago.

Of organic matter in solution a vory considerable quantity was found in tho drainage-water. The character of the soluble organic matter in the drainage is, however, very different from that in the sowage. It contains very much less ammonia, or ammonia-yielding mattor; and, ospecially in periods of active vegetation, will doubtless, frequently be derived from vegetable matter within the soil, rathor than directly from the sewage.

A very important point to remark is, that, whilst the sowage scarcely contained an appreciable amount of nitric acid, the drainage contained more nitrogen in that form than as ammonia; the result being that the soil had retained a considerably less proportion of that important manurial constituent of the sewage than would have been supposed had only the more partial analyses been made.

The general result was, that, practically, the whole of the insoluble or suspended matter of tho sewage was retainod by the soil; and that, of the constituents of the sewage, whother in suspension or in solution, thoso which are of the most value, bocauso the most liable to become relatively exhausted, were the most efficiently retained. Nevertheless, the drainage-water still retained so much of potassa, phosphoric acid, ammonia, and nitric acid, as clearly to show that tho sowage had not bcon perfoctly deprived of its valuable manurial matters, and also so much of total soluble matter, especially of solublo organic matter, as to show that it had not been by any means perfectly purified.

There is, indeed, a limit to the power which a soil possesses of removing substances from solution, or of preventing thoso already absorbed from being dissolved in water passing through it, the result being dependent on the physical and chemical characters of the soil itsolf, and on the amount and composition of the fluid passing through it. So far as the solublo organic matters of the drainage are derived from vogotablo matter within the soil, it is a question whether thoro will not always be a considorablo amount in that passing from land covered with luxuriant vegetation. So far, however, as the nitrogen of tho drainage oxists in the form of nitric acid, it is a pretty satisfactory indication that the orgauic matter has, to a greet extent, already passed the stago of doleterious putrescenco.

In tho Rugby exporiments the arrangemonts were not such as to allow of the water drained from ono portion of the land being passed over another; but at Beddington, near Croydon, a great portion of the water does duty twice, and sometimes throo times; and from results kindly communicated by Mr. Latham, the engineer to tho Croydon Board of Health, and givon in the following table, it would appoar that there the wator eventually passes from the land in a stato of much greater purity than was tho caso in the Rugby experiments.

The figures show much about the same amount of ammonia in the sewage of Croydon, as was found on the average in that of Rugby; but the amount in the Croydon drainage was extremely sma'l. It is unfortunate that the quantity of nitric acid was not also determined; but we are informed that it undoubtedly exists in some amount in the drainage from the Beddington meadows. Still, although formerly the Croydon Board had to meet numerous law-suits on account of the pollution of the river by the sewage, the fluid is now so far purified before being discharged, that those having the right of fishing in the river have found it woith while to fix gratings to prevent the fish going up the main outfall from the sewage-irrigated land.

Table XII.

Partial Analysis of the Croydon Sewage before application, of the Drainage-water from the irrigated land, and of the River Wandle, above and below the Drainage Outfall from the irrigated land.

Constituents.	Croydon.		River Wandle.	
	Sewage.	Drainage.	Above Drainage Outfall.	Below Drainage Outfall.
	Grains per Gallon.			
Inorganic matter	48·30	23·40	18·56	20·16
Organic matter	52·20	2·40	1·44	2·08
Total solid matter.........	100·50	25·80	20·00	22·24
Ammonia	6·70	0·21	0.18	0·18

The results obtained in regard to this part of the subject—that of purification—however interesting and important, must still be looked upou as little more than initiative; but there can be no doubt that, when large quantities of sewage are applied to grass land, the arrangements should be such as to allow of the drainage-water being collected and re-used in such a manner as to insure as far as possible both complete utilisation and complete purification. It must be admitted, however, that further experience, and further investigation, are still wanting, to determine what amount of sewage, provided the drainage-water be properly re-distributed, can be safely applied to a given area, under different conditions of soil and subsoil, and under different conditions of season, so as to insure its sufficient purification.

Experience of Common Practice in the Utilisation of Sewage.

Leaving the results of experimental inquiry, it will be well briefly to notice those of practical experience hitherto, in regard to the value and utilisation of town sewage. The instance most frequently quoted is that of the neighbourhood of Edinburgh, relating to which some particulars are given in the following Table:—

Table XIII.

Relating to the Sewage-irrigated Meadows near Edinburgh.

Names of Meadows.	Imperial Acres under Irrigation.	Approximate Population contributing to each Acre.	Approximate Quantity of Sewage available for each Acre.
			Tons.
Lochend, Spring Gardens, and Craigentinny	285	337	20,500
Roseburn and Western Dairy	80	112	17,000
Quarry Holes	8	562	65,000
Broughton Burn	6	1,666	102,000
The Grange................................	16½	302	97,000

These tabular statements are chiefly based upon direct information, obtained in part from Mr. McPherson, the Edinburgh City Surveyor, and in part from the occupiers or managers of the respective meadows. To prevent misunderstanding, however, it must be explained with regard to them, that, as water-closets are not universal, and as the sewage is frequently allowed to pass unused, the records of the amount of population contributing to, and of sewage available for, each acre, do not show the amounts actually utilised, but only approximately the total amounts available, whether used or wasted.

Sewage has been applied to some portions of the land in the neighbourhood of Edinburgh for about 200 years, to a considerable portion for more than sixty, and to most of that now under irrigation for moro than thirty years. In two instances arrangements have been made for raising the sewage, by pumping, an inconsiderable number of feet; but the cost has been found too great to allow of a sufficient quantity being applied per acre, and hence the application in this way has been much limited, if not on some portions of the land entirely abandoned. The application is

confined to meadow-land and Italian rye-grass, and the distribution is entirely by means of open runs. When Italian rye-grass is grown, the land is periodically broken up, and one or two other crops taken without sewage before laying down again to grass. The application to ordinary rotation crops on arable land forms no part of the system adopted.

There is no doubt that at Edinburgh larger amounts of sewage are applied per acre than anywhere else, and that it is under those conditions that there are there obtained larger amounts of produce per acre than anywhere else. Nor is there any doubt, on the other hand, that there is, at Edinburgh, not only very great waste of manurial constituents, but very imperfect purification of the sewage. Hence the experience there, however interesting and important in some points of view, cannot be taken as the foundation either of estimates of the value realisable in practice by the utilisation of given amounts of sewage, or of the sewage of a given population, or of safe conclusions as to the amount of sewage that can advantageously be applied per acre when the drainage has to be passed into a river, which may have to serve as the water-supply of other towns, instead of, as at Edinburgh, having an immediate outfall into the sea.

It may be mentioned that generally four or five crops of grass are obtained per acre annually, amounting, according to circumstances, to 30, 40, 50, 60, and even more tons per imperial acre, and selling for prices varying from £8 to over £40 per acre, but averaging perhaps about £25. These results are, indeed, sufficiently striking, and well merit careful inquiry and consideration; but, for the reasons above stated, the exact practice of Edinburgh is not applicable to towns generally, and is especially inapplicable to inland towns.

Table XIV. summarises the results of the experience of the most important instances of sewage utilisation in other localities.

Table XIV.

Relating to Sewage-irrigation in various localities.

Towns.	Population contributing.	Acres. Original.	Acres. Reduced.	Crops.	Annual Payment to Towns.
Alnwick ...	6,500	270	0	Arable and grass; abandoned	Nothing
Carlisle ...	22,000	70	...	Meadow-grass; all grazed	?
Croydon ...	16,000	250	...	Meadow and rye-grass	£300
Malvern ...	4,000	50	...	Grass	Nothing
Rugby.......	6,700	190 280	20 100	Meadow and rye-grass Meadow; chiefly grazed	£50
Tavistock ..	6,000	95	...	Grass	Nothing
Watford ...	4,000	210	7 35	Rye-grass—Summer Meadow-grass—Winter	£10
Worthing .	7,000	42	...	Grass; not yet at work	Nothing

At Alnwick the late Duke of Northumberland put down machinery and piping for the distribution of the sewage of the town over about 270 acres, of mixed arable and grass land. After a very short time the tenants who had the free use of the sewage for the cost of its application, abandoned it altogether; and the bailiff of the district, who reports the failure, expresses his opinion strongly against the general applicability of sewage to arable land.

At Carlisle, the sewage of only a portion of the town is utilised. It is deodorised by Mr. McDougall's disinfecting fluid, and raised by steam power some ten or twelve feet into an open cut, from which it is diverted for application to the land by movable iron troughs. It is estimated that from 8,000 to 9,000 tons of sewage are applied per acre per annum. It is understood that little or nothing is realised by the town, but that the tenant makes a considerable profit by sub-letting the sewage-irrigated land for grazing purposes.

In the neighbourhood of Croydon, as already referred to, the sewage of nearly 20,000 persons is applied to about 250 acres of meadow and Italian rye-grass. It is calculated that more than 6,000 tons of sewage are available for each acre. A considerable portion of the fluid is used two or three times over; and it finally passes from the land pretty satisfactorily purified. It is estimated that, after making deduction of £4 for rental, the *gross* return per ton of sewage applied is, at the present prices of the produce, with Italian rye-grass from ¾d. to 1d., and with meadow-grass from ½d. to ¾d. The sewage is not applied in any systematic manner to other crops, but it has been tried on a small scale to root-crops. An enlargement of the area of irrigation is contemplated, which will, if carried out, somewhat reduce the amount of fluid and excretal matters available per acre below the quantities above stated.

About twelve years ago, arrangements were made for collecting the sewage of Rugby in a tank, from which it is pumped, by a twelve-horse power engine, through iron pipes laid down for the distribution over about 470 acres of mixed arable and grass land. Up to last year 190 acres were held by Mr. James Archibald Campbell, but he has gradually limited the area of application, and during the last few years has abandoned the use of hose and jet, excepting occasionally on a small scale, and confined the application almost exclusively to from twelve to twenty acres of meadow and Italian rye-grass. The remainder of the land, amounting to about 280 acres, has passed through the hands of two tenants, both of whom are said to have sustained considerable loss. The last of the two had confined the application almost exclusively to about 100 acres of grass land, and applied the sewage almost entirely by open runs. The whole is now in the hands of the landlord, Mr. G. H. Walker, who, it is understood, is contemplating the abandonment of the use of steam power, pipes, and hose and jet, and the application to a limited area by means of gravitation.

The general result at Rugby is, then, that after about a dozen years of practical experience, with arrangements adapted for the application of small quantities of sewage per acre, to arable as well as to grass land, and to all crops, the area has been greatly limited, the use to any other crops than meadow and Italian rye-grass is quite exceptional, and the application by means of steam-power, pipes, and hose and jet, will probably soon be entirely abandoned. It may be added that, at the time of the experiments of the Commission, the sewage, which was considerably stronger than that of the Metropolis, cost the tenants only about ¾d. per ton at the hydrants in the fields; yet, rather than incur the loss of using it at that cost, both were glad to get rid of it to the Commisson, at rates which, though three times as high during the six summer as during the six winter months, averaged the year round scarcely, but very nearly, 1d. per ton at the hydrants.

Some years ago, the Earl of Essex laid down pipes for the application of the sewage of Watford, by pumping and hose and jet, to about 210 acres of mixed arable and grass land. The results which his Lordship obtained on the application of only 134 tons of sewage per acre to wheat have frequently been held to be conclusive proof of its applicability in small quantities per acre over large areas, to arable land, and to all crops. But in the evidence given by his Lordship before the Sewage Committee of 1862, he stated, very emphatically, that his great error had been the piping of too much land; that he required 5,000 tons per acre for 10 acres of rye-grass; and that, applying the remainder to 35 acres of meadow, he had none to spare for wheat. In other words, although the abandonment of one acre of rye-grass would set free sewage enough for nearly 40 acres of wheat, if applied only at the rate which yielded the large gross return per ton of sewage so frequently quoted, yet his Lordship's practical experience had led him to prefer the application to the one acre of rye-grass rather than to the nearly 40 acres of wheat. Further, his Lordship gave it as his opinion that sewage would not be profitable to the farmer unless he could have it from ½d. to ¾d. per ton.

Referring to the question of the application of sewage to corn crops, it may be stated that, in an experiment made by the Commission at Rugby, with oats, a very high gross money return per ton of sewage was also obtained. The experiment was made in the unusually productive season of 1863, and with sewage of about double the average strength of that of the Metropolis, applied during a period of very dry weather. The results were, therefore, quite exceptional, and cannot be taken as affording any indication of what might be expected from the application of small quantities of sewage to corn crops generally, on different soils, and on the average of seasons. There cannot, indeed, be a doubt, that to obtain a maximum gross value of produce from a given amount of sewage, it should be applied in small quantities per acre, and in dry weather. But sewage is produced in large daily amount at all seasons, and must be disposed of as soon as it is produced. It must, therefore, be applied in winter, when of comparatively little value, as well as in summer, when of more, and it would frequently be quite inapplicable to arable land. Moreover, to obtain an increased gross money return per ton of sewage by using it on a comprehensive scale for corn and other ordinary rotation crops, would involve the extra cost of main distribution over at least a ten-fold, if not frequently a twenty-fold area, and require the application to a great extent by the expensive means of pipes and hose and jet, instead of by the economical one of open runs.

At Malvern and Tavistock the application of sewage to grass land has now been carried on for some years, but at Worthing it has only very recently been commenced.

From this short review of the experience of practical men who have undertaken the utilisation of sewage with a view to profit, it appears that, wherever arrangements have been made for the application of small quantities over large areas, to corn and other rotation crops on arable land, and by means of pipes and hose and jet, the undertaking has either been entirely abandoned, or the area greatly limited, and the application confined almost exclusively to meadow and Italian rye-grass. On the

other hand, the undertakings which have been the most successful from the agricultural point of view are those in which the arrangements have been adapted for the almost exclusive application to grass, and the application to other crops is only exceptional.

The practical conclusions deducible from the whole inquiry may be briefly stated as follows:—

1. It is only by a liberal use of water that the refuse matters of large populations can be removed from their dwellings without nuisance and injury to health.

2. That the discharge of town sewage into rivers renders them unfit as a water supply to other towns, is destructive of their fish, causes deposits which injure their channels, gives rise to emanations which are injurious to health, is a great waste of manurial matter, and should not be permitted.

3. That the proper mode of both utililising and purifying sewage is to apply it to land.

4. That, considering the great dilution of town sewage, its constant daily supply at all seasons, its greater amount in wet weather when the land can least bear, or least requires more water, and the cost of distribution, it is best fitted for application to grass, which alone can receive it the year round. It may, however, be occasionally applied with advantage to other crops within easy reach of the line or area laid down for the continuous application to grass.

5. That, having regard both to urban and rural interests, an application of about 5,000 tons of sewage per acre per annum, to meadow or Italian rye-grass, would probably, in the majority of cases, prove to be the most profitable mode of utilisation, though the quantity would have to be reduced, provided experience showed that the water was not sufficiently purified; and it is pretty certain that the farmer would not pay ¾d., and it is even very doubtful whether he could afford to pay ½d. per ton, the year round, for sewage of the average strength of that of the Metropolis (excluding storm-water) delivered on his land.

6. That the direct result of the general application of town sewage to grass land would be an enormous increase in the production of milk, butter, cheese, and meat; whilst by the consumption of the grass, a large amount of solid manure, applicable to arable land and to crops generally, would be produced.

7. That the cost or profit to a town of arrangements for the removal and utilisation of its sewage must vary very greatly, according to its position, and to the character and levels of the land to be irrigated. Where the sewage can be conveyed by gravitation, and a sufficient tract of suitable land is available, the town may realise a profit; but, under contrary conditions, it may have to submit to a pecuniary sacrifice to secure the necessary sanitary advantages.

METROPOLITAN WATERS, 1866.

The Metropolitan Association of Medical Officers of Health have issued their report for the month of December, with a retrospective view on the condition of the waters supplied to the metropolis during the whole year 1866. From this valuable paper we extract those data which are of a more than local or ephemeral interest.

PERIODICAL FLUCTUATIONS IN THE COMPOSITION OF THE WATERS.

The fluctuations which take place in the quality of the water during the succeeding months of the year are sufficiently marked to indicate the influence of the seasons. This may be seen from the following table, which exhibits the average composition of the water supplied to the metropolis by the Thames companies during each of the twelve months of the last two years:—

Months.	Total Solid Matter per Gallon.	Oxydisable Organic Matter.	Months.	Total Solid Matter per Gallon.	Oxydisable Organic Matter.
	Grains.	Grains.		Grains.	Grains.
January	21.22	0.79	July	17.28	0.63
February	21.61	0.67	August	17.57	0.59
March	20.45	0.73	September	17.51	0.61
April	19.38	0.49	October	18.80	0.62
May	18.99	0.47	November	20.56	1.04
June	18.49	0.62	December	20.78	1.01

Thus it appears that from October to February the total amount of solid matter in the water gradually rises to its maximum, which is rather more than 21 grains per gallon, and then it as gradually declines until at the beginning of summer it is no more than about 17 grains per gallon. Throughout the months of July, August, and September it remains at nearly the same proportion, and then with the advance of autumn it slowly increases. The quantity of organic matter in the water is at its maximum in November, directly after the fall of the autumn leaves; and its minimum is in the month of May. The same facts are observed with the water supplied by the New River and the East London companies, whose sources of supply are very nearly of the same quality as the Thames, but it is not so with the deep chalk water of the Kent Company.

INCREASE OF WATER SUPPLY IN FIFTEEN YEARS.

A special chapter of the return is devoted to a review of the results of the investigation into the character of the water supply of the Metropolis during 1866, and a comparison of the same with that of 1851, when the last Government Commission was appointed to examine it. At that time the population of London was 2,362,236, and the quantity of water daily supplied by all the metropolitan companies was 45,885,900 gallons. This was at the rate of 19.4 gallons per head. At present the estimated population of London is 3,067,536, and the average daily supply of water is 92,734,000 gallons, which is at the rate of a little more than 30.2 gallons per head. As far, therefore, as quantity in concerned, the increase is considerable, for it is nearly 60 per cent. on the average daily supply of 1851; in fact, while the population of London has increased during the last 15 years to the extent of only one-third, the water supply has been more than doubled.

IMPROVEMENTS IN THE QUALITY OF WATER.

In the period of 15 years, from 1851-66, the chemical composition of the Metropolitan waters has likewise undergone a marked improvement. In the year 1851 the average proportion of solid matter in the Thames supply was 21.43 grains per imperial gallon; whereas in the year which has just expired it has been only 19.64 grains. The same is the case with the water obtained from other sources than the Thames; for the amount of solid matter in the Kent water has fallen from 29.71 grains per gallon to 27.01; in the New River, from 19.50 to 18.97: and in the East London, from 23.51 to 20.81.

REDUCTION OF ORGANIC IMPURITY.

That improvement which is the most important from a hygienic point of view, consists in the reduction of the proportion of organic matter contained in the water. In 1851, the quantity of organic and other volatile matter dissipated by heat from the solid residue of the Thames supply was 2.46 grains per gallon; in 1866 it has been only 1.05 grains. In the Kent water it has declined from 2.61 grains per gallon to 1.04; in the New River water from 2.79 to 0.89; and in the East London water from 4.12 to 1.04.

RECAPITULATION.

The whole of the facts stated heretofore is best illustrated by the following comparative table of the quantity and quality of the water supplied to the Metropolis in 1851 and 1866:—

	1851	1866
Population	2,362,236	3,067,536
Average daily supply—Gallons	45,885,000	92,734,100
Ditto, per head	19.4	30.2

Companies.	Years.	Total solid matter per gallon	Organic matter &c., lost by Heat	Hardness.	Average daily supply.
		Grs.	Grs.	Deg.	Gallons.
Grand Junction	1851	21.72	3.07	14.0	3,541,700
	1866	19.74	0.98	13.1	8,551,800
West Middlesex	1851	22.67	2.75	14.6	3,334,000
	1866	19.32	0.95	13.0	8,102,300
Southwark and Vauxhall	1851	21.08	1.51	15.0	6,013,700
	1866	20.02	1.02	13.0	12,367,000
Chelsea	1851	21.28	2.38	14.4	3,940,700
	1866	19.31	0.94	13.0	7,748,000
Lambeth	1851	20.40	2.59	14.2	3,077,300
	1866	19.83	1.16	13.0	8,694,100
Kent	1851	29.71	2.61	16.0	1,079,300
	1866	27.01	1.04	18.3	5,927,200
New River	1851	19.50	2.79	14.9	15,435,600
	1866	18.97	0.89	14.1	22,729,700
East London	1851	23.51	4.12	15.0	9,036,000
	1866	20.81	1.04	14.8	18,614,000

This improvement in the quality of water has been effected in three ways:—1. By selection of better sites for the collection of the water. 2. By careful processes of filtration through acres of fine sand, &c.; and 3. By the storage of the filtered water in covered reservoirs.

Whether other improvements can still be effected is a subject for careful inquiry; and it is likewise matter for calm and deliberate investigations whether the water supply has had anything to do with the recent epidemic of cholera. Doubtless the numerical facts contained in this table tend to falsify the popular opinion on this subject, which was very generally entertained last summer.

OCCASIONAL NOTES FROM SCOTLAND.

THE NEW EDINBURGH IMPROVEMENTS.

Edinburgh, the metropolis of Scotland, the modern Athens, is about the best, if not the best, abused town in the world. Planted on a situation, picturesque; filled, at one time, with the greatest intelligences; the seat of Law, Medicine and Gospel, a curse seems to be upon her, and the words that shattered Babylon, are written upon her walls. Not that she is threatened by foes from without; not that she has ceased to be admired by all visitors; but internal strifes, and the pig-headed councils of her rulers, have brought her to that sweet pass, that in a few years she will be as fallen as Tyre, as desolate as the great Sahara.

The citizens of Edinburgh are notorious builders. Scarce a week passes but a new barricade appears in Princes-street, which renders the thoroughfare nearly impassable, while the busy tearers down of the old tenement, scatter the lime and dirt upon the breeze, blinding therewith the eyes of the passers-by, and in no figurative language filling their mouths and nostrils with dust and ashes. Then when the work of reconstruction takes place, great carts of stone, drawn by savage horses, who are lashed by heavy whips, and tortured by sore backs into fury, obstruct the thoroughfare, imperilling life and limb. The wooden fences put up to screen off the work, bristle with nails, and the incautious belle, finds on passing along a great rent in her skirt, the beau, one of his coat tails wanting. All this is mighty pleasant to those who escape such disasters, but scarcely so to those who are the victims. A bill is now lodged with Parliament to have an enlarged area for the development of these nuisances, the running the city into debt, entailing heavy taxation, if not final bankruptcy, and the unhousing of numberless people.

The Right Hon. William Chambers, the Lord Provost of Her Majesty's City of Edinburgh, is truly a very extraordinary man. By industry he has risen from keeping a book-stall, through the printing and author grades, till now he is Lord of Glenormiston, and Chief Ruler of Auld Reekie. Born at Peebles, he has endowed that remarkably wealthy, populous, and intelligent village with an Institution, which is as empty of visitors as it is full of works of little value.

Mr. Chambers has cast his eyes upon the back-bone of Edinburgh, of which the Castle Rock is the head, and Holyrood Palace, with its adjacents, are the feet. He has discovered that the wynds and closes which form the ribs of the skeleton, are densely populated, that crime flourishes there, and that disease reigns there triumphantly. And he said, all this must be done away with; we must haul down a lot of these buildings, form new streets, and carry them even three-quarters of a mile south from this backbone. He accordingly prepared a plan, and laid it before the Town Council. Over it that learned body did battle for many days, and it was only by a small majority that a Bill was ordered to be prepared for Parliament.

Now we do not for an instant dispute that the wynds and closes are densely populated, and that disease and crime are also to be found preponderating there. But who is to blame for this? No other than the sapient Town Council. As Governors of George Heriot's Hospital, they have in their hands great parcels of ground, for which they have received over and over again, offers to feu for the purpose of building workmen's houses. This they have refused, considering a seedsman's gardens to be of more benefit to the community than the providing of wholesome houses for the labourers in these gardens, who are consequently forced to seek the wynds and closes of the High-street and Canongate for habitations, and thus add their quota to the dense population. Dr. Begg, to whom all honour must be given for his philanthropic endeavours to ameliorate the condition of the working classes, has for years wrought at the providing them with good houses, and in some districts blocks of buildings have been raised for that purpose. But these are but drops in the bucket. The population of the condemned territory would require a town to be built for themselves, with houses of a moderate rent, not with such exorbitant ones as Edinburgh is cursed with.

But there is another point for consideration with regard to this population. It is composed principally of people of low morality, and consequently of low habits, who are never happy unless when crowded together, and who were they to get a room a-piece in one of the crack houses in the West-end of London, with £5 a week and nothing to do, would be found every man and woman of them, congregated in the kitchen, and whisky floating in buckets full. This is one great section, the section of crime, immorality, and disease, and because the Town Council will not do their duty, and have something like moderation in inhabitants kept in the low dens, the honest artisan and his virtuous family are to see the roof torn off their house, and to be sent houseless upon the world. And this is precisely what the Lord Provost's Bill purposes doing. A noble scheme!

And now we will come to the question of expense. The Bill will be bitterly contested, and so it should, as only a very small section of the community are directly in favour of it. That expense will be heavy. Then the cost of buying up old properties, pulling them down, and building up new, no one can accurately calculate; even the original contemplated expense was found too low, and competent judges affirm that it will cost at the lowest £800,000; others say a million and a-half, if not two. Where, in the name of the Bank of England, is a poor city, already heavily taxed, to find this money?

But there is a proposition made. In the matter of the Water of Leith Drainage, only that section of the city contiguous to the stream was taxed, as it was held by the other districts that it was for its benefit, pestilence sitting open-mouthed on the banks, and for no others. It did not appear to these wiseacres that that pestilence could spread through the other parts of the town, and that it was as much the interest of the dwellers in these other parts to have the improvement made as for the dwellers on the banks of the classic Leith. Now, however, that the Lord Provost's scheme comes into view, it is proposed to tax those already heavily taxed for the Leith drainage, as well as the exempted districts. This the dwellers on the water of Leith distinctly refuse to agree to, but offer, if the assessments for both the drainage and the new improvements be carried over the entire city, to pay their share, as they have the same interest in the latter that the other districts declared they had in the former. Of course this proposal could not be listened to, so we shall have a second edition of the Annuity Tax warfare, for few men taxed for the Water of Leith Drainage will pay a tax for a district two miles distant from them, and with which they have no earthly connection.

Let us in conclusion look at Edinburgh's recent improvements and buildings. Lord Cockburn-street does not pay at all as was expected, and it was one of the same style of schemes as the present. Might one ask when that celebrated instance of Scottish grandeur of design, and poverty of execution, the National Monument, will be finished; when the Scott Monument, of which we are all so proud, will be completed according to the original plan; or when we may see the stone laid of the Albert Monument? Are the people to be supposed such idiots as to allow half the town, and that the most populous, to be laid in ruins, when we know funds cannot be had to rebuild it? Is there not something in the Scriptures regarding a man who began building a tower without computing the cost, and stuck in the middle of it, to the amusement of his neighbours? Have we not enough of stone and lime abortions, to the disgrace of our beautiful city, without turning it, in verity, into modern Athens? We admit improvements are wanted, but the improvements are more houses for the working classes, when the evils of overcrowding will be done away with; as for crime, that will exist in the very best regulated cities as long as human nature exists, and we have a beautiful instance of that in Paradise and our first parents, where there was no particular overcrowding.

A Provost of Leith gave his name to an Act of much contested worth. If the Lord Provost of Edinburgh expects Parliament to do as much for him, we wish he may get it.

STATISTICS OF RAILWAY CASUALITIES.

The railway net of the United Kingdom is the most expensive of all Europe, and the number of trains travelling on each line is on an average double of what it is in France or Germany; the average speed of the trains is likewise by far larger than on the Continent. Yet all these circumstances combined cannot account for the astonishing frequency and gravity of railway accidents in this country, as compared to Continental Europe. Doubtless the disasters of this kind continually occurring on the lines in the United States are far more numerous than in Great Britain, but this neither justifies nor mitigates the abnormal state of things complained of. The latter becomes more and more intolerable, and an efficient action on the part of the legislature and the executive more and more urgently requisite, with a view to put a stop to the carnage going on continually before our eyes. From a parliamentary return lately issued, of the number of railway casualties in 1865, we extract the following particulars, from which it will appear that those accidents that could not have been foreseen and prevented, do not amount to as much as one per cent. of the total.

There are, upon an average, at least four persons killed in a week upon the railways of the United Kingdom. The total in the year 1865 was 221, and the variation in the annual number of late has been very small. There were 216 in 1862, 184 in 1863, 222 in 1864. Still more striking is the regularity in the number of passengers killed; in every one of the four years it was either 35 or 36—one to every ten days. The number of passengers injured has varied greatly: it was 536 in 1862, 401 in 1863, 706 in 1864, 1039 in 1865, a few accidents in 1865 having affected a large

number of persons, one at Colney Hatch causing injuries (the greater number very slight) to 250 passengers; one at Wemyss Bay hurting 75, and four others, injuring some 40 or more passengers in each instance. There were killed on our railways in the year 1865, 36 passengers, 122 servants of companies or contractors (an incomplete return), 9 persons at level crossings, 46 trespassers, and 8 other persons. Of the 221 deaths, only 49 were occasioned by the accidents which occurred to trains in the course of the year, 30 by accidents occurring to passenger trains, and 19 by accidents to goods trains; 13 passengers lost their lives by their own fault; almost twice as many (23) were killed by accidents beyond their own control; 21 of the 23 were killed through passenger trains getting off the rails. Of the 1,039 passengers injured in 1865—the largest number ever recorded—only five brought it upon themselves by their want of caution; 802 were injured in 65 collisions of trains, 74 in 11 trains getting off the rails, 71 in 7 trains turned wrong at points, 12 from breakage of parts of carriages or engines, 75 from a train running into a station at too great a speed. One passenger was killed through falling while rashly getting over buffers of carriages in motion at a station: five lost their lives in getting out of trains while in motion; two in attempting to get into trains in motion; and five in incautiously crossing the line at stations. These are the thirteen passengers returned as killed by their own want of care. A boy, not a passenger, lost his life through attempting to ride on the foot-board of a carriage before the train had stopped; and a girl who had come to meet some friends who were passengers, was run over and killed while crossing the line with them. This danger of crossing, or partially crossing, is forced upon the public in some instances, even at busy and confusing stations. Four passengers were injured in getting out of or into trains in motion, and one in incautiously leaning out of window near a tunnel. A passenger on an Irish line was killed by leaning out of a carriage window as the train was leaving a station, his head coming in contact with the pillar of an arch, which was then (not now) only 5½in. from the window; this is set down as a death occurring from a cause beyond the passenger's control. A person riding on the step of a carriage to speak to a passenger fell off and had his leg crushed. One accident, which occurred in the night on the Midland Great Western of Ireland, is expressly distinguished as caused by malice; a rail had been unscrewed and displaced; one person, a passenger, was injured on this occasion. Ten other accidents resulted from passenger trains getting off the rails, but the cause is not stated. In one collision trains met on a single line—a passenger train and coal train; three persons were killed and fifteen injured. Of the nine persons killed on public level crossings, three were a child, a deaf boy, and a farm servant driving sheep across the line. In the course of the year three persons placed themselves before approaching trains, and wilfully ended their lives by submitting to be run over. In the six years, 1860-65, 1,382 persons were killed and 4,460 injured, on the railways of the United Kingdom.

WHO INVENTED THE SCREW PROPELLER?

RESSEL v. SMITH.

In our issue of December 1, 1866, we published a letter from the "North American Ressel Committee," claiming on behalf of the late Joseph Ressel, the priority of the invention of the screw propeller. At the present moment Francis Pettit Smith is generally recognised in this country not as the first *inventor*, strictly speaking, but as the man who made the first practical application of the spiral as a motor for the propulsion of steam vessels; in fact, his name is generally considered to be as closely connected with the screw propeller as James Watt's with the steam engine, and George Stephenson's with the modern locomotive. In this respect his priority is thought unquestionable, and was recognised as far back as 1851, in the Jurors' Report of the First International Exhibition,* and somewhat later, in John Bourne's Treatise on the Screw Propeller. Up to within the last ten or fifteen years, the professional public of most countries of Europe and America were in the habit of drawing from works published in England, their notions of and information on practical mechanical engineering—Great Britain being generally deemed the classical country for this as well as most other branches of industrial science. Thus, the historical researches of British authors on the invention of the steam engine were accepted as final, and the names of Savery, Newcomen, and Watt have preserved all their splendour and glory, notwithstanding the industrious propagation of the trumpery claim advanced by Arago on behalf of one Solomon de Caus, some thirty years ago; for a time the latter obtained in some quarters, but soon its utter shallowness became apparent, and the name of the alleged pioneer relapsed into that oblivion from which nothing but the age's craving for sensation stories had extracted it, and it was finally discarded as a sham by Professor Reuleaux, of Zürich, decidedly an unprejudiced man.

The Ressel claim presents itself under a different aspect, although its very injudicious advocate, Herr Hoffmann, has represented it in the *Gartenlaube* as a parallel to the Caus "revindication," so fully disposed of by this time. It is alleged by the supporters of this claim that Joseph Ressel, and no other, first applied the spiral to the propulsion of a vessel in water; that he was consequently entitled to the whole, or at least a large share of the pecuniary reward voted by the Imperial Parliament in favour of the real inventor or inventors; and, last not least, that notwithstanding the disregard of his claim in the distribution of the grant, the *honour* of the priority belongs to him, and to him alone. Now the evidence on the ground of which they mean to make out his title, is of a somewhat complicated nature, the *pièces justificatives* are rather numerous* and the arguments somewhat involved. Still, we shall endeavour to state to our readers the case, such as it is understood by the claimant's supporters.

The idea of propelling a vessel by a screw fitted to its stern was entertained by Joseph Ressel, as far back as 1812. On March 27th, 1827, a "biennial privilege," *i.e.* a patent, was granted to Ressel, then inspector of the I. R. Littoral Dominial Forests, for "the invention of a wheel, resembling an endless screw, for the propulsion of vessels."—One Bauer, having been let into the inventor's confidence, proceeded to England with a view to working the invention.—On June 10th, 1828, one Charles Cummerow, merchant in the City of London, took out a patent for "certain improvements in propelling vessels," communicated to him by a certain foreigner residing abroad. The latter, it is stated, was either Bauer or Ressel himself; the invention, it is maintained, was decidedly Ressel's.—Immediately after the grant of the patent for Austria, a joint stock company was started for working it, by applying screw propellers to steamers designed to ply between Trieste and Monfalcone. One William Morgan, being at that time in possession of a license for the navigation of *paddle* steamers between Trieste and Venice, the Trieste police would not permit Ressel's *screw* steamers to infringe on Morgan's licence, and upon Ressel's appeal, the I. R. "General Court Chamber" confirmed the decision of their subordinates. The screw steam navigation between Trieste and Montfalcone having, therefore, been determined on, the building of a screw steamer was commenced, a Trieste merchant, Carlo Fontana, advancing the necessary funds. Many difficulties intervened, but at last the vessel, called *La Civetta*, was launched, and the engine having been approved of by a committee of official inspectors, several trial trips were made. A steam pipe having burst during the fourteenth tip, the paternal police authorities of Trieste prohibited all further experiments. And there the matter ended. Ressel, being entirely destitute of pecuniary means, connections and influence, was unable to push it any further, and for many years persevered in the humble position of an I. R. Littoral Forest Inspector.

The facts as stated thus far, admit of but little contestation. The proofs are such as can hardly be considered doubtful. It being, moreover, an established fact that Mr. Smith's invention was not patented till 1836, nor worked till 1838, the questions at issue would be simply:

1st. Whether Ressel's "wheel resembling an endless screw," as fitted on board *La Civetta*, was a *bonâ fide* screw propeller, in its present acceptation.

2nd. Whether the abortive trials of his vessel, in 1828, can fairly be considered as a practical working of the screw propeller.

As regards the first question, it is maintained by all the advocates of the Ressel claim, that the "screw wheel," as patented in 1827, and as applied to the stern of *La Civetta*, was a fac-simile of the one shown in the annexed illustration. If so, the question answers itself in the affirmative; but we may observe here, that we have seen no authentic copy either of the Austrian specification alluded to, or of the drawings of the first propeller executed by Ressel. As to the second question, we would rather "reserve judgment." Although we feel inclined to think that altogether the evidence in favour of Ressel is very strong, it is yet apparent that thus far his case is not fully made out, and it may safely be left to the unbiassed

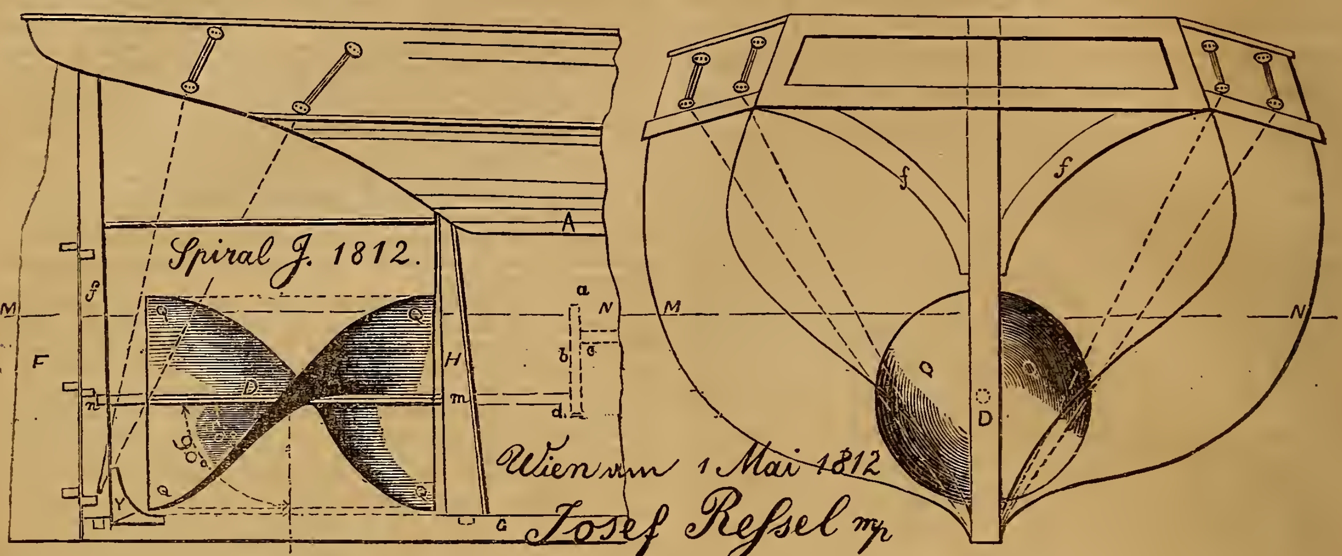
* Smith, F. P., Greenwich.—Prize Medal.—A complete series of models, illustrating the gradual advance and improvement of the screw propeller, which was proposed and brought into general use by this gentleman.—(Jurors' Report, Great Exhibition, 1851, Section A, Class V., No. 3, page 210).

* The following pamphlets, periodicals, &c., may be referred to:—
1st. Charles Cummerow's Specification of Certain Improvements in Propelling Vessels, No. 5730—1828.
2nd. Biografia di Giuseppe Ressel. Published by the Ressel Memorial Committee of Trieste. (Trieste, 1858).
3rd. Heinrich Ritter von Littrow, Gutachten über die Priorität Josef Ressels. (Trieste, 1862).
4th. Unsere Zeit. Part 78. Pages 388 and following. Essay by Professer Karmarsch. (Leipzig, Brockhaus, 1863).
5th. Joseph Ressel, &c. Eine erläuternde, dokumentirte Denkschrift. A Pamphlet on the Prize Decerned by the English Government to the First Inventor of the Screw Propeller. By the North American Ressel Committee. (New York, J. Mühlhæuser, 1865).
6th. Archiv für Seewesen. Year II. Part IV. Page 171. (Trieste, 1866.)
7th. Eine deutsche Klage, von Friedrich Hoffmann, in No. 45, page 702 of the *Gartenlaube*. (Leipzig, E. Keil, 1866).

discernment of the public to weigh the facts in favour of against those adverse to his claim, and then strike the balance.

Now, the illustration here annexed is a reducing to two-thirds of the one contained in "Ressel's Biography" (No. 2), and purporting to be a

Fig. 1. Fig. 2.



fac-simile of Ressel's original drawing. His handwriting, at all events, has been officially authenticated. The explanation of the letters of reference, as given by the inventor, is as follows:—

In Fig. 1.—D, the spindle of the spiral; Q, the spiral in a state of inactivity; F, the rudder; G, the keel of the ship; Y, the iron prolongation of the keel; H, the stern post; *f*, back of stern post; *n*, bearing (*Drehungshülse*) for the core (*Kern*) of the screw; *m*, casing (*Hülse*) filled with grease, for the core of the spiral in the stern post, preventing water entering the ship.

In Fig 2.—D, core of the spiral; *q*, the spiral itself, in a state of non-activity.

In Fig. 1.—*bd* the small, *ac* the large cog-wheels, forming the mechanism for transmitting to the spiral the motion derived from the steam engine.

To Cummerow's specification two drawings similar to, but by no means identical with, our diagrams, are appended. As a specimen of the style in which the specification is written, we transcribe its commencement, running as follows:—

To have an exact idea of the spiral, one must figure to one's self a pivot, for instance, of wrought iron, on which is fixed, in the shape of a vice or wing of brass, wire of a quarter of an inch thick, of an elevation of 3ft. from the centre of the pivot, and which runs round it along a length of 9ft. One must likewise figure to one's self, with this vice, the water as the original vice, and with a force giving a central motion to the vice, which, applied to a boat, will produce, by this same motion, the translation of the boat. To recognize all the advantages of the spiral on the wheels made use of till now in steamboats, one must examine the effect of both, and the following results will be found, &c.

The drawings are hardly more lucid. Taking it for granted that Cummerow's patent was Ressel's, we yet question the allegation of his advocates, that it formed the nucleus to Smith's patent of 1836. At any rate it would be difficult to prove that Smith was acquainted with Cummerow's patent, at the time when he made his experiments on models of screw-propelled boats on the horse ponds of his farm at Hendon, the more so, as Cummerow's specification was printed only in 1855. Besides, the burden of proving the allegation rests on the accuser, not the accused; until such proof be forthcoming, the charge remains a gratuitous conjecture.

We now proceed with our statement of facts, gathered from the various pamphlets and papers before us. Ressell's invention having lain dormant and fallow for many years, he, on September 18th, 1852, read in the *Osservatore Triestino*, the following paragraph:—

Some years since the English Admiralty offered a prize of £20,000 to him who could make out the best claim on the priority of the invention of the screw propeller, *i.e.*, the first application of the Archimedean helix to steamship propulsion, in lieu of paddle wheels. One Mr. Carpenter, Captain in the Royal Navy, now seeks to prove that his claim is the best founded.

Ressel at once took such steps as he thought might lead to a recognition of his priority by the British Admiralty, and the award of a long-yearned-for recompense. After some considerable delay, taken up by official formalities, Ressel's application, with papers and documents, was transmitted to the Admiralty by the Austrian Consul in London, Mr. Wm. Schwartz. This was on the 15th of March, 1853. It having been previously intimated to the Consul by the secretary of the Admiralty, that "the sum of £20,000 to which he referred, had been paid by the British Government to several persons who possessed patents relating to the subject," no reply was made to the formal application. Only as late as 1858, a year after Ressel's death, when the claim for the restitution of the documents on the part of the survivors was supported by the powerful intercession of Archduke Ferdinand Max, the following reply was elicited from the Admiralty:—

Admiralty, 11th March, 1858, S.

Sir,—With reference to your letter of the 9th inst. (No. 279), in which you request that the documents in support of the claims of Joseph Ressel for a participation in the reward offered to the inventor of the screw propeller, and which are supposed to have been forwarded to this office, may be returned to you, I am commanded by my Lords Commissioners of the Admiralty to acquaint you, that, after a careful search, no trace can be discovered of the documents in question ever having been received in this department.

I am, Sir, your most obedient servant,

R. G. Romaine.

Now there is decidedly some mystery about the disappearance of these papers, and the accident may have been rather unfortunate, should Ressel's original drawing of 1812 have been among them. The supporters of the claim ascribe the "alleged" loss of the documents to a desire on the part of the British Admiralty to silently discard the title obviously owned by a "foreign" inventor. Those at all acquainted with the organisation and spirit of any British administration will, of course, at once repudiate such an insinuation as baseless and gratuitous. It seems to us, after all, that in the whole Ressel affair, from beginning to end, the German "green table" combined with English "red tape" in frustrating all the inventor's designs and endeavours. A suicidal short-sightedness and imbecility on the part of the Austrian Government defrauded Ressel of the fruits of many years' labours and sleepless nights; and British officialism has, in the affair of the £20,000, sinned no more against the foreigner than it did against the most deserving native, Francis Pettit Smith,—the latter not being included in the list, hitherto not yet published, of the five successful applicants. Thus, it is self-evident that the assertion brought forward by the New York Ressel Committee (Artizan, Nov. 1866), collapses in itself.

Having now given the facts as stated, and sifted them to some extent, we are evidently led to infer that there is apparently a great deal of foundation in the claim so energetically advocated by the inventor's son, r. Heinrich Ressel, by the various Ressel committees, and many countrymen of the deceased. We may here quote Professor Karmarsch's opinion (No. 4). According to him:—

The leading features of the present screw propeller are as follows:—

1st. A *single* screw is sufficient to propel the vessel.

2nd. The screw revolves continually and entirely under water. It is not only partially or periodically submerged, like a rudder or paddle-wheel.

3rd. The screw occupies that place, in every respect most favourable, viz., the stern of the ship, in an enclosed space (the well) between sternpost and rudder.

4th. The screw shaft lies in the vertical plane of the keel, parallel to the latter, and enters across the stern-post into the body of the vessel, there to be connected to the steam engine.

All these distinguishing features are combined in Ressel's screw; they are all, or partially, wanting in the projects and attempts of every one of his predecessors.

The National Academy of Sciences, of Washington, upon the request of the North American Ressel Committee, examined Ressel's claim, and decided in its favour; but, whatever the authority of that body, its

decision can form but a one-sided verdict. *Audi alteram partem.* We would rather, in concluding, suggest that claims of this kind should be examined by international juries, being naturally above the suspicion of a bias in favour of one or another of the applicants. In Ressel's case, the same as in all similar ones, the real truth would thus become apparent, and be established on solid grounds.

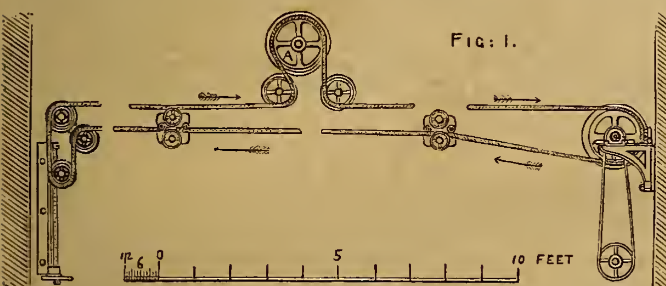
INSTITUTION OF ENGINEERS IN SCOTLAND.

ON AN IMPROVED OVERHEAD TRAVERSING CRANE, WORKED BY POWER.

By Mr. WM. SMITH, Eglinton Engine Works.

The travelling crane which forms the subject of this paper, was erected at Eglinton Engine Works, Glasgow, about twelve months ago, and since that time has been regularly at work. The convenience and saving effected by its use has been so great that the writer has thought a description of the construction and mode of working it might be acceptable to the members of the Institution.

FIG: 1.



The erecting shop in which the crane is placed, is 200ft. long by 53ft. wide inside the walls, and, although the original intention was to place two cranes in this shop, the rapid manner in which this one does the work, makes it quite unnecessary, unless it might be for the purpose of lifting heavier loads than one crane is capable of doing.

The crane is driven by power by means of an endless cotton cord, ⅝ths of an inch diameter, extending the whole length of the shop, supported at intervals by guide pulleys, and returned round a pulley at the one end, which is fixed in slides and tightened and adjusted by means of a screw and hand wheel, as shown in Fig 1. The slides and screw are nine feet long, and allow of adjustment until the cord has stretched 18ft., after which it may require to be cut shorter and spliced over again. This tightening pulley may also be adjusted in some cases by means of a weight instead of a screw.

Fig. 2 shows an elevation of the crane resting on the walls of the shop; Fig. 3 is a plan; and Fig 4 an end elevation of the crane. Two wrought-iron girders form the beams of the crane, and are fixed to two cast-iron carriages, each having two wheels for the longitudinal rails. The crab is constructed of two cast-iron cheeks, set on four wheels to move transversely, and carries the chain barrel, gearing, and small platform for the man in charge.

The driving-cord moves at the rate of 1800 feet per minute, and is first taken over a V pulley on the crane 3ft. diameter, marked A in Figs. 2 and 3, and shown in section Fig. 5. On the same shaft as this pulley, a spur pinion is fixed, driving a spur wheel on the end of the shaft, B. This shaft extends the whole length of the crane, and gives motion to the main driving shaft of the crab, DD, Fig. 3, by means of a small vertical shaft and mitre wheels, marked C, Figs. 2 and 3. When the cord is put in motion, the shaft, B, and the main driving shaft of the crab, DD, are always in gear. From the shaft, DD, all the working parts of the crane are put in motion by means of three hand wheels, E, F, G, Fig. 3. In connection with each hand wheel, a worm moves a short lever which throws a friction clutch in gear for working, reversing, or holding in a neutral position at pleasure.

The hand wheel, E, puts in gear the clutch and spur wheels, which work the chain-barrel, H, for lifting and lowering the load. This barrel is made large, with grooves chased in at the proper pitch to receive the chain, and to accomplish the whole lift of 20ft. without riding the chain. A fast and slow motion is given to the barrel by means of double spur wheels and pinion, N, Fig. 3. A friction strap, K, Figs. 2 and 3, is attached to the mitre wheel, I, of this motion for the purpose of lowering the load. A set of three sheave blocks is also used to assist in reducing the motion of the lift.

The hand wheel, F, puts in gear the clutch and spur wheels, which

FIG: 2.

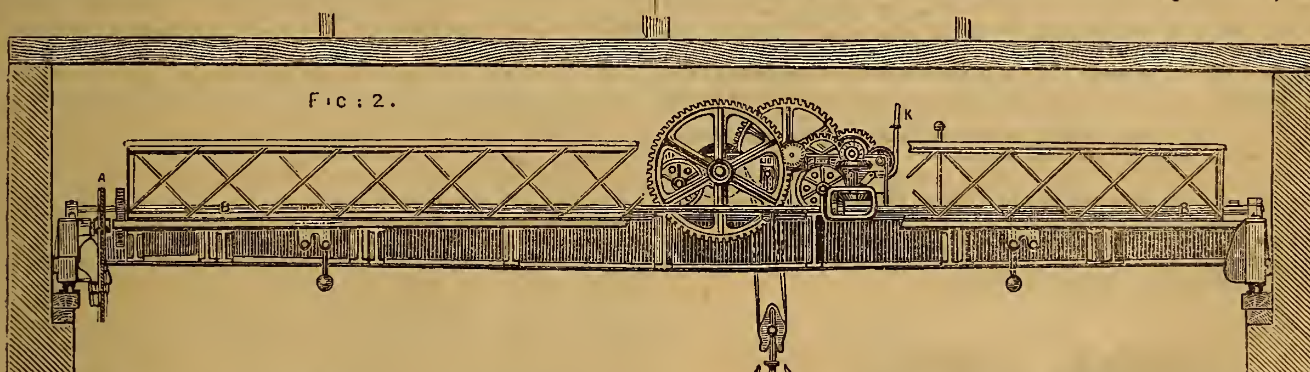
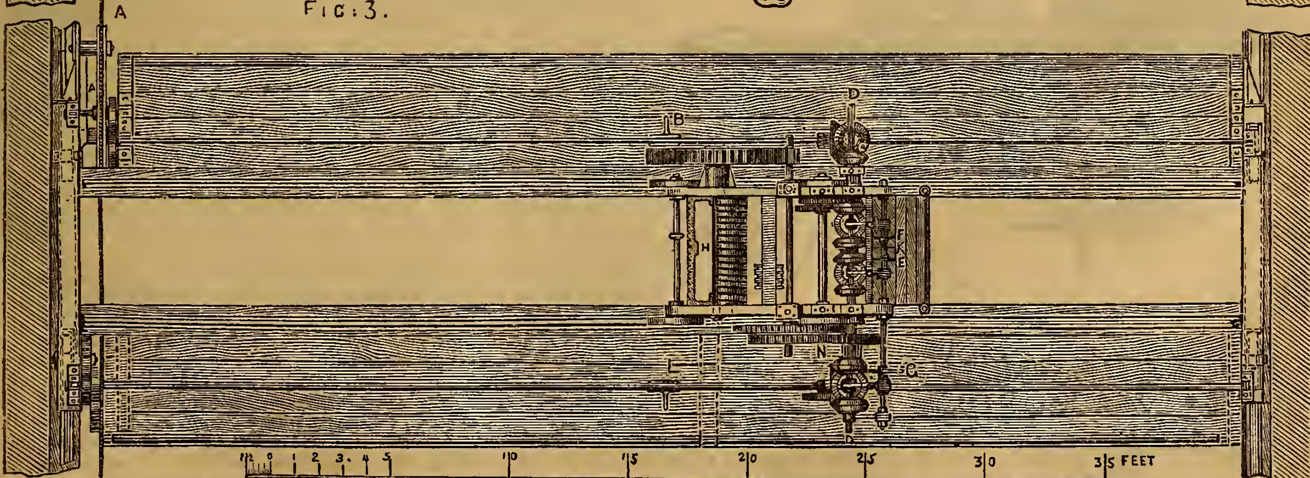


FIG: 3.

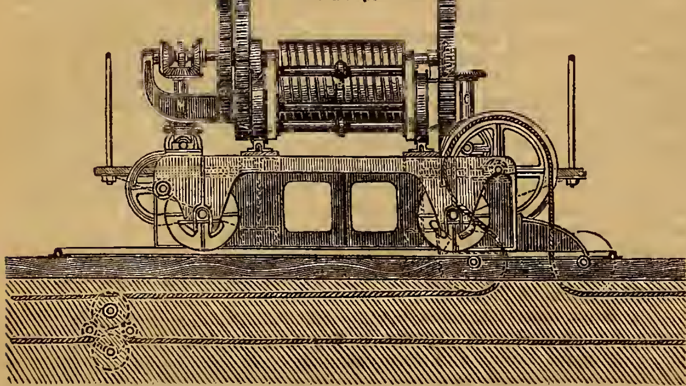


cause the crab to traverse either way at pleasure on rails fixed on the beams of the crane.

The hand wheel, G, puts in gear the clutch, bevel wheels, and vertical shaft, M, Fig. 3, for driving the shaft, L. This shaft extends the whole length of the crane, and on each end of it a spur pinion is fixed, driving simultaneously one of the carrying wheels at each end of the crane by means of spur wheels, giving motion to the crane either way the whole length of the shop.

The heavy loads, from $2\frac{3}{4}$ tons up to the maximum load of 15 tons, are raised at the rate of 1ft. 5in. per minute, giving a leverage of 1270 to 1. With light loads, the speed of lifting is increased to 7ft. 4in. per minnte, giving a leverage of 245 to 1.

Fig: 4.



The speed at which the crane traverses the shop longitudinally, is 41 feet per minute; and the speed the crab traverses the shop transversely is 44 feet per minute.

The whole power requisite for working the crane when fully loaded, is transmitted to the counter-sbaft upon which the driving-cord pulley is fixed, by a $3\frac{1}{2}$-inch leather belt, working on fast and loose pulleys 18 inches diameter, making 191 revolutions per minute. By means of a belt-lever and two pull-cords, the crane can be put in motion and stopped by the workman on the platform at any point.

On each side of the crane there is a wooden platform, supported from the wrought-iron girders by cast-iron brackets. A small platform is also connected to the crab, upon which the workman in attendance stands, and from which all the hand wheels for startiug and stopping the different motions of the crane are under his control.

The long shafts, B and L, Fig. 3, which extend the whole length of the crane, are each supported at intervals by three tumbler-bearings, and also by a fixed bearing from the cheeks of the crab. Each shaft has also a small groove, running the whole of its length for fixing the bevel wheel connecting it with the crab, and at the same time permitting the wheel to slide on the shaft when the crab is traversing.

Fig: 5.

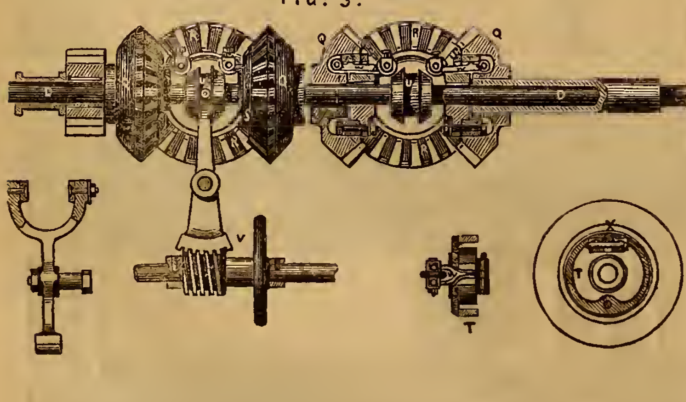


Fig. 5 shows plan and sections of two pairs of the friction clutches used on the shaft, DD, for the purpose of starting and stopping the different motions of the crane; one pair is shown in section, and one pair in plan. The two mitre wheels marked Q are bushed with brass, and are loose npon the shaft DD; they are also coupled by the mitre wheel, R, which revolves on a stud, and serves for reversing the motion. The two discs, SS, are keyed fast to the shaft, DD, and have fitted and fastened to them the expanding rings, T, which are shown in a neutral position, ready to be acted on by moving the conical block, U, either way, by the lever worm and hand wheel, V. When the conical block, U, is thus moved, it expands the friction ring, T, by means of a short lever, W, and wedge piece, X, and fixes either of the mitre wheels, Q, transmitting the power one way or the other, as required.

One man is quite capable to work and keep the crane in order, effecting a saving in ordinary working of four to five men daily.

The crane is provided with handles fitted to each end of the shaft, DD, for working it by hand in cases of emergency.

INSTITUTION OF CIVIL ENGINEERS.

At the meeting on the 8th ult. Mr. C. H. Gregory, Vice-President, in the chair, six candidates were balloted for, and declared duly elected, including five members, viz.:—Mr. John Clark, Engineer to the Municipal Council of Shanghae; Mr. Lewis Henry Moorsom, Resident Engineer in Charge of Works at the London-road Station, Manchester, of the London and North-Western, and Manchester, Sheffield, and Lincolnshire Railway Companies; Mr. James Long Parker, Executive Engineer of the 1st grade in the service of the Government of India, Meerut; Mr. Charles Sacré, Chief Engineer to the Manchester, Sheffield, and Lincolnshire Railway Company; and Mr. Edwin Thomas, Engineer to the Regent's Canal Company; and one Associate, viz., Mr. Adam Fettiplace Blandy, Resident Engineer, Millwall Docks.

ON SHIPS OF WAR.

By Mr. John Bourne.

The author stated that, in his opinion, the only vessels capable of carrying sufficient thickness of armour to resist modern ordnance were those built on the Monitor or turret system, the invention of Captain John Ericsson, of New York. He maintained that although broadside vessels might be useful and even necessary, and he could imagine cases where they might almost be indispensable, yet that no broadside fleet would be safe unless accompanied by a flotilla of Monitors. It was simply a question of preponderance of forces, and in any future maritime war, the strongest armour and the heaviest guns must necessarily prevail. He proposed that any Monitors now to be built should have side armour eighteen inches thick backed by four feet of oak, and a turret twenty-four inches thick carrying two 20-inch wrought-iron guns. Such a vessel, he contended, could be constructed on a displacement but little different from that of the *Bellerophon*, and it would not only be impenetrable now, but would probably remain so for some years. He considered it had been shown, by ample experience, that such vessels were seaworthy, afforded comfortable accommodation for the crew, were healthful, and popular with sailors. In the common iron-clad, as the armour had to be spread over a high side, it was necessarily thin and weak; whereas in the Monitor system, the sides being very low, the area to be protected was reduced to a minimum, so that with the same displacement the armour might be made of great thickness, such as would be impenetrable by the heaviest existing ordnance. The *Kalamazoo* class of Monitors had side armour fourteen inches thick backed by several feet of oak, and these vessels possessed great facility of evolution, as they were fitted with balanced rudders and twin-screws. In both the armour and the guns the broadside system was one of diffusion, the turret or Monitor system one of concentration. The former had been adopted in France and in England, the latter in America, where about sixty vessels of this class had already been built, and recently by Russia and some other continental powers. In the broadside system the only material innovation on the model of the old men-of-war was in the application of iron armour to the sides. In some cases the armour was not extended to the bow and the stern, but only the central part of the sides and a belt at the water line were protected, and armour bulkheads were carried across the ship, before and behind the protected portion of the sides, so as to form the central part of the vessel into a rectangular fort. This was the principle on which the *Bellerophon* and other recent vessels had been built, and its advantage was that it enabled thicker armour to be applied. In the Monitor system the guns, which were of large calibre, were carried in one or two cylindrical towers of iron, and the weight of the broadside was concentrated in one or two enormous shot, which had momentum enough to go through the armour of any of the broadside vessels of the royal navy of Great Britain.

There were certain points of dissimilarity between the turret ships of Captain Coles and those of Captain Ericsson, the most material being that the sides were not nearly so low in the former as in the Monitors, and the armour of the sides and the turrets could not consequently, with any given displacement, be made so thick; nor would it be possible, with safety, to reduce the height of the sides, owing to the turrets being carried on rollers on the lower deck, thus passing through openings in the upper deck, which it was difficult to keep tight without jamming the turrets: the openings to the engine-room were also merely covered with gratings, or were otherwise similarly unprotected. In the Monitors, on the contrary, the turrets revolved upon a metal ring, on the upper deck, and all the

openings to the interior of the vessel were through the top of the turret, or through shot-proof trunks or pipes, so that even if the deck were washed by the waves, water could not enter the vessel so long as the deck remained watertight. Captain Coles' vessels had been but little tested in actual war, and therefore the objections urged against his system had yet to be proved. On the other hand the Monitors had been found, during a war of unprecedented magnitude, to be both shotworthy and seaworthy; they were confessedly unequalled in their power of penetrating other vessels and of resisting penetration themselves.

As an illustration of the main features of the structure of the Monitor vessels, a description was given of the American war steamer *Dictator*, built by contract under Ericsson. Her length was 314ft., beam 50ft., and draught of water 20ft., with 800 tons of coals, and when fully equipped, she was fitted with a single turret, carrying two Rodman guns, each of 15in. bore; Ericsson maintaining that one turret was superior to several. She was propelled by a pair of engines with cylinders 100in. diameter and 4ft. stroke. The diameter of the screw was 21ft. 8in., with four blades, and 34ft. pitch. Steam was supplied to the engines by six boilers, with a double tier of furnaces, numbering fifty-six in all. The heating surface of the boilers was 34,000 square feet, and the grate area 1,120 square feet. The chimney was 10ft. in diameter, and 8in. thick at the base, and was provided with a shell-proof grating, placed about 6ft. above the level of the deck. The engine room was ventilated by means of a copper fan, of large diameter, suspended horizontally under the deck, and driven by a small donkey engine, bolted to the deck beams. The fan, which was not enclosed in a casing, drew the air, which it sent into the engine room, through a pipe or cylindrical trunk, 4ft. in diameter and 8in. thick, carried high above the deck. The air thus forced into the engine room passes thence into the boiler room, to maintain the combustion in the furnaces, which was also aided by two Dimpfel blowers, each 78in. diameter, applied under the turret, through the top of which the air was drawn. The sides of the ship were only 16in. above the water line, and were defended by armour 6ft. deep and 4ft thick, 10½in. of this thickness being of iron, and the remainder of oak. The turret was of iron, 24ft. inside diameter, 9ft. 6in. high, and 15in. thick. The vessel tapered to a point at each end, the side armour being continued so as to form a ram both at the stem and at the stern; and by this projection at the stern both the screw and the rudder were effectually protected. The weight of each shot discharged by the 15in. gun was 425lbs., and the quantity of powder burnt every charge was 60lbs.

Comparing the destructive and resisting powers of such a vessel as the *Dictator* with an iron clad like the *Bellerophon*, the latter carrying on each broadside five guns of 10½in. bore, besides two guns at the bow and three at the stern of 7in. bore, it was contended that none of these guns could pierce the iron turret, or low sides of the former, or the deck, composed as it was of oak planks, 9in. thick, covered with 2in. of iron, and that all the parts of the vessel were equally strong to resist the forces that might be brought to bear against them. It might be supposed that the *Dictator* would be easily run down by the *Bellerophon*, but this was argued to be impossible, even if the former were stationary, nor did it agree with experience, for the *Merrimac*, when she encountered the first Monitor and tried to run over her, suffered far more damage from the attempt than her opponent. It was, however, by the power of the guns and by the thickness of the armour, that the issue of the contest would be mainly determined; and while the guns of the *Bellerophon* would be powerless against the armour of the *Dictator*, even if fired in converging salvos, the *Dictator's* guns would easily pierce the armour of her adversary.

The main point connected with the structure of the Monitors, which had provoked controversy among naval men, was whether it was possible to make heavy vessels, so low in the water as the Monitors were, safe at sea. Even if this should be doubted, the necessity for the employment of Monitors for the protection of ports, harbours, and estuaries, was not the less exigent. But although, in the nautical mind, the ideas of seaworthiness and height of side were indissolubly associated, it was believed that it would not be difficult to show, that there was no necessary connection between these conditions. In the Monitors, the deck was as tight as the bottom, and the only openings to the interior were through towers which the waves could not enter. Moreover, such vessels did rise to the sea, and it was found in practice, that towers of the height of those of the *Dictator* were quite adequate to enable the vessel to encounter with safety the heaviest seas to which any vessel could be subjected. During the two years the Monitors were exposed, on a stormy coast, to all kinds of weather, they proved to be both shotworthy and seaworthy, and the healthiest vessels in the American fleet. The voyages, however, of the *Monadnock* round Cape Horn, and of the *Miantonomah* across the Atlantic, had caused the most plausible of the objections to the system, to be abandoned. Various other objections were noticed, as, for instance, the want of liveliness imputed to the Monitors, but this it was argued was a material advantage in any vessel requiring to take an aim with heavy guns, since it must make the aim more sure. In conclusion, the author said, what it concerned the Government and the country to know was, that in the Royal Navy there were vessels of at least equal powers in guns and in armour to those possessed by any other nation, so that in the event of a naval war, the broadside fleet might not be disabled or captured, from the want of a flotilla of protecting Monitors, whose function it would be to encounter any similar vessels belonging to the enemy.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

The following is an abstract of the Chief Engineer's Monthly Report presented at the ordinary monthly meeting of the Executive Committee of this Association held at the Offices, 41, Corporation-street, Manchester, on Tuesday, November 27th, 1866, Hugh Mason, Esq., of Ashton-under-Lyne, Vice-President, in the chair.

"During the last month 342 engines and 503 boilers have been examined, as well as three of the latter tested by hydraulic pressure. Of the boiler examinations, 408 have been external, 9 internal, and 86 entire. In the boilers examined, 77 defects have been discovered, 10 of those being dangerous.

TABULAR STATEMENT OF DEFECTS, OMISSIONS, &c., MET WITH IN THE BOILERS EXAMINED FROM OCT. 27TH to NOV. 23RD, 1866, INCLUSIVE.

DESCRIPTION.	Number of Cases met with..		
	Dangerous.	Ordinary.	Total.
DEFECTS IN BOILER.			
Furnaces out of Shape	1	...	1
Fracture	1	5	6
Blistered Plates	...	3	3
Corrosion—Internal	...	2	2
Ditto External	4	5	9
Grooving—Internal	...	...	...
Ditto External	...	...	...
Total Number of Defects in Boilers	6	15	21
DEFECTIVE FITTINGS.			
Feed Apparatus out of order	...	...	...
Water Gauges ditto	...	15	15
Blow-out Apparatus ditto	2	6	8
Fusible Plugs ditto	...	...	...
Safety Valves ditto	...	3	3
Pressure Gauges ditto	1	3	4
Total Number of Defective Fittings	3	27	30
OMISSIONS.			
Boilers without Glass Water Gauges	...	...	...
Ditto Safety Valves	...	1	1
Ditto Pressure Gauges	...	...	...
Ditto Blow-out Apparatus	...	2	2
Ditto Feed back pressure valves	...	20	20
Total Number of Omissions	...	23	23
Cases of Over Pressure	...	...	...
Cases of Deficiency of Water	1	2	3
Gross Total	10	67	77

Of some of the defects mentioned above, further particulars may be given.

Injury to Furnace Crowns.—The case referred to arose through the attendant's leaving the blow-out tap of his boiler open, with the fires burning. The boiler, which was one of a series of three set side by side, and connected together, had recently been let off for cleaning, and the fireman was getting up steam to set it to work again, when observing that there was more water in the

gauge glass than necessary, he opened the blow-out tap at the bottom of the boiler to lower it, and forgetting a few minutes after that he had done so, went away to oil the machinery, leaving the boiler with the fires burning and the water running out through the open trap. He was absent about a quarter of an hour, and on his return found the boiler empty, and the furnace crowns red hot. The boiler was fitted with a low water safety-valve, as well as a fusible plug on each furnace, but as there was no steam the safety-valve could sound no alarm, and as there was no water, though the fusible plugs both melted, the fires were not damped. In such cases as this, which are by no means infrequent, of fires being left burning in empty boilers, it is clear that neither low water safety-valves, nor fusible plugs are of any avail, though the difficulty may be met by the very simple plan of blowing out at the surface of the water, by means of a scum tap placed above the level of the furnace crowns. There was a scumming apparatus in this boiler, but the outlet was unfortunately connected with the blow-out at the bottom, whereas the two should have been distinct, and the outlet for the scumming apparatus above the level of the furnace crowns. Had this been the case, even though the scum tap had been left open, it could only have lowered the water to its own level, and being above the furnace crowns could not have laid them bare; while the charge of blow-out taps at the bottom of boilers, should be trusted solely to the head engineer, and the spanner kept by him under lock and key. These recommendations have already been given on a previous occasion in the report for September last, when referring to a precisely similar case of injury to furnace crowns.

Deficiency of Water.—This case was met with on the fireman's going to work on a Monday morning, when he found the boiler empty, the fires burning, and the furnace crowns red hot. The boiler had been cleaned out on the previous Saturday, and left on the following day with the fires banked up, the steam at a pressure of 9lb. per square inch, and the water about twelve inches above the furnace crowns, when the attendant, on arriving on the Monday morning, found it in the condition just stated. It appears that the joint of the mudhole cover, placed at the bottom of the front end plate of the boiler, had frequently given trouble from leakage. It was made with yarn, while the faces of the cover and mouthpiece were very rough. There appeared, on examination, little room to doubt that the water had escaped through this joint, while this view is confirmed by the fact that near to this boiler there was an excavation for a new one, the ground of which was found by the attendant on his arrival in the morning to be quite wet, just as if the contents of the boiler had been drained into it. Had the joint surfaces of the cover and mouthpiece been properly got up and brought together metal to metal, the leakage just described could not have occurred.

Fracture.—This defect is, perhaps, one more pregnant with danger than any before met with in the inspections of this Association. It was found in one of three boilers, all of which were about 7ft. 6in. in diameter, connected together, and worked at a pressure of nearly 60lbs. on the square inch. The defect consisted in a crack, which ran from rivet hole to rivet hole of the inner overlap of the plate, at a longitudinal seam of rivets near to the top of the boiler, the depth of the crack being half the thickness of the plate, while it extended to within a few inches of its entire width. Had it developed as many cracks do, so as to lead to the rupture of the plate, the most serious consequences must have resulted. Not only would the shell of the boiler in question have been torn in pieces, but the adjoining boilers thrown from their seat, and possibly exploded from the shock, as has been found to be the case under similar circumstances. The boiler was but about three years old, so that it shows that entire examinations are important even for new boilers.

Explosions.

Before entering on the explosions for the past month, fuller details may be given of Explosion No. 49, which was but briefly referred to in the last report. It is one of considerable interest, and I made a personal examination of the fragments a few days after the explosion occurred.

No. 49 Explosion occurred in one of our large commercial ports, at about three o'clock on the afternoon of Tuesday, October 9th, to a small portable boiler employed on board a sailing vessel in driving a winding engine for hauling on board the cargo. This explosion is of a most melancholy character, not simply from the fact of eight persons having been killed, but from their deaths being perfectly gratuitous, since they arose from the improper construction and equipment of the boiler, which might easily have been corrected; while two other men were killed as recently as the 21st of April last by a similar boiler, which was turned out by the same maker, and burst from a precisely similar cause, full particulars of which were given in the Association's monthly report for May last, and presented gratuitously as usual to the public at large through the medium of the scientific and daily journals.

The boiler, which was not under the inspection of this Association, was of about four horse-power and of vertical construction, having an internal conical firebox containing two horizontal water tubes running across it. Its size was quite diminutive, which, as has been stated on previous occasions, it is important to notice in connection with the very fatal results of the explosion, since the danger of small boilers is apt to be overlooked. Its height was only about 5ft. 6in., while the diameter in the shell was but 2ft. 6in., and in the internal furnace 2ft. at the bottom, and 6in. at the top, the thickness of the plates being ¼in. in the shell, and ⅜in. in the furnace tube, while the working pressure was about 100lbs. on the square inch, the bursting strain, as stated by the makers, being as high as 500lbs.

The equipments of this boiler were defective both in the case of the manhole and safety valve. The manhole, which measured 13in. horizontally by 10in. vertically, was not strengthened as it should have been with a substantial mouthpiece, nor even with a wrought iron ring, but had an ordinary internal cover, held up by one or two bolts suspended from arched bridges, notwithstanding the high working pressure and the lightness of the plates already described. The safety valve arrangement was most objectionable. Every boiler should have two good valves, whereas this had but one, and that of a most dangerous class. It was fitted with a spiral spring, precisely similar to the one described in the report for May last, which proved, on being submitted to a most careful hydraulic test, to be so rigid as to prevent the valve's rising sufficiently to admit of a free escape of steam. A compression of a little more than ¼in. raised the load upon the valve from a pressure of 80lbs. on the square inch to 200lbs., in addition to which the two nuts by which the spring was held down were loose, and neither guarded nor locked in any way, while the pillar bolts that carried them had neither stop collars nor ferrules to prevent their being overscrewed, so that the valve could at any time be tampered with, or the engineman, in replacing the valve after taking it out as he would have to do occasionally for cleaning, &c., might easily put on 100lbs. more than the ordinary pressure without knowing it. Indeed it was a matter of perfect haphazard whether he loaded the valve to 100 or to 200lbs. There was only a turn of the nut between safety and explosion, or a single thread between life and death. Such a valve was indeed no safety valve at all, but only a delusion and a snare, totally unfit to be put on any boiler whatever, but more especially so on a small portable one, which from the fact of these boilers not always being in the hands of the most skilled attendants, should be the more carefully contrived for simplicity and safety.

The boiler burst at the unguarded manhole, eight rents starting from it, which ripped up the shell into fragments, and tore them away from the furnace tube, which was left uninjured. The manhole cover, which faced towards the stern of the ship before the explosion, was shot through the sides of a poop cabin in that direction, while the main portion of the shell recoiled towards the bow, and embedded itself in a deckhouse, the domed crown plate of the shell being thrown upwards, and afterwards found on the deck of a neighbouring vessel, while the bulwarks were so splintered that they presented the appearance of having been in action. Added to this, five men were laid dead on the deck, and two others blown overboard, while another was so seriously injured that he lingered but a day or so before he died. The sight of the dead bodies laid out on deck, and the boiler plates bathed in their blood, is described as perfectly sickening; and reference to these facts is made that the disastrous consequences may be appreciated of turning out improperly-finished boilers, the importance of which is so sadly overlooked. A consideration of the direction in which the fragments of the boiler were thrown, the manhole cover being shot in one direction, and the main portion of the shell recoiling in the other, if taken in conjunction with the original position of the boiler prior to explosion, as well as with the eight rents which radiated from the unguarded manhole, prove incontestably that it was at that unguarded manhole the boiler first gave way.

The cause of the explosion was made a matter of the most searching investigation by the coroner, who indefatigably pursued the inquiry for three entire days. Neither the makers of the boiler, however, nor the intermediate party who had sold it to the shipowners, were present at the inquest, both excusing themselves on the plea of illness, but the makers were represented by their lawyer, as well as by their manager. In their defence they attempted, as is usual in these cases, to throw all the blame upon the poor engineman who had been killed by the explosion. The legal gentlemen tried hard to prove that the engineman had allowed the furnace tube to be laid bare and overheated, through neglecting his feed, and that water must then have been dashed upon the hot plates, either from the sudden introduction of the feed, or starting of the engine, in consequence of which an excessive and uncontrollable pressure of steam had been instantaneously generated, which burst the boiler into fragments with the force of an ignited charge of gunpowder. It may be questioned whether such consequences would have resulted even if the furnace tube had been overheated as supposed, since the feed water was pumped into the boiler at the bottom, or nearly so, so that it could only have submerged the furnace tube little by little as it rose and cooled it down gradually, which could not, it is thought, have produced any rapid generation of steam. In support of this a case mentioned in a previous report may be referred to, in which water was pumped into a red-hot boiler without having any other effect than so straining the seams from violent contraction that they leaked like a sieve, and the water ran out of the boiler faster than the engineman could pump it in, which was the first intimation he had of anything being wrong. These remarks, however, must not be misunderstood. It is not by any means intended to countenance the introduction of the feed into boilers after the furnace crowns have been laid bare and overheated: under such circumstances, the fire should be withdrawn, as soon as practicable, and the furnaces allowed to cool down gradually. The question raised is whether the contact of water with hot plates would instantaneously generate such a sudden pressure of steam as to burst the outer shell. This inquiry is a most important one, especially since so many explosions are popularly attributed to this cause. It deserves to be submitted to the test of practical experiment as the only satisfactory way of determining the question.* But whether the legal gentleman's hypothesis be correct or not, it will be seen on referring to the facts of the case, that it does not apply in the present instance. It is true that the furnace tube was slightly discoloured a little below the water line, for a belt of about 12in. in width, but at the same time the soot remained on the inner side of the furnace, and the plates were not in any way distorted, nor the seams opened, while the two transverse water tubes, which passed through the middle of the flame, were entirely unaffected either at their plates or seams of rivets, which, it is thought, is scarcely consistent with the view of the furnace tube having been overheated, and at the same time submitted to a high pressure of steam. In addition to this, it was given in evidence that the engine was not working at the moment of the explosion, but standing

* At the meeting of the committee at which this report was read, the propriety of attempting to determine this question by actual experiment was discussed, and it was unanimously agreed that the subject was of sufficient importance to justify this course, and, therefore, it was resolved that a boiler should be purchased expressly for the purpose of practical test.

during the dinner hour, so that the feed was not being pumped in, as supposed, or the water agitated by the working of the engine; while, in addition, there appears to have been plenty of water in the boiler at the time, since, although the glass tube was broken, the water was up to the lower tap but about ten minutes before the explosion, when at the same time the attendant was seen to screw down the safety-valve, with a brisk fire burning, and the engine, as already stated, standing still. From this it will be seen that the assumption of the legal gentleman, that water was dashed on to the furnace tube when overheated, is quite unsupported by the evidence. The manager differed from the legal gentleman just quoted, and did not attribute the explosion to shortness of water, but to excessive pressure of steam in consequence of the attendant's having screwed down the safety-valve; but did not consider it improper to turn out such safety-valves without stop ferrules, so as to prevent their being overloaded in this way, and thought them quite as safe as any others. He also considered the boiler to be stronger at the unguarded manhole than at the seam of rivets, that it would have stood a test of 500lbs. on the square inch, and that there must have been about that pressure of steam in it at the time of the explosion. In short the boiler was a good one and suitably equipped, but the attendant was either careless or ignorant, and nothing could have prevented the explosion. Two scientific witnesses, as well as myself, gave evidence at the inquest. One of them, who was for years the chief engineer of the *Great Britain* steamship, and subsequently of the *Great Eastern*, thought the boiler, fitted with such a safety-valve, might fairly be likened, from its murderous propensities, to one of the "infernal machines" of French notoriety; and he had, shortly after the explosion occurred, on examining a similar boiler made by the same makers, seen the engineman screwing down the safety-valve, though with steam at a pressure of 90lb. per square inch; and he mentioned this fact to show the unguarded nature of these safety-valves, the ease with which they could be tampered with, and the impropriety of turning out boilers with a single one only. The three scientific witnesses arrived unanimously at the conclusion that the explosion did not arise from shortness of water, but from the weakness of the boiler at the unguarded manhole, in conjunction with the highly defective safety-valve! or, in other words, from simple pressure of steam, which the safety-valve was too defective to relieve and the boiler too weak to withstand.

The coroner, in summing up, stated that he considered such a safety-valve as the one in question, which could be loaded either to 20lb. or 500lb., or, indeed, locked fast, while it had no graduated scale to show the danger, or stop ferrules to prevent it, was a most deadly instrument, and that it was a fatal mistake to have placed it in the hands of an ordinary engine-driver. This the jury did not fail to appreciate, and while they brought in a verdict of "Accidental Death," as directed by the coroner on account of the divided responsibility, they added "that they were of opinion that the equipments of the boiler were bad in the extreme, and that such safety-valves ought at once to be removed from all steam boilers, at all events from those used in their own port;" and also, "that after the sad explosion which took place on the 21st of April last, of a boiler made and equipped by the same makers as the one under consideration, the jury were of opinion that the makers were highly censurable for sending out such dangerous equipments."

It is thought that the coroner did much to prevent the recurrence of other explosions by his painstaking investigation on the present occasion, and if full investigations were always made, and the truth fully spoken as well as fully circulated, much would be done to diminish the number of fatal explosions. The fact of a number of these dangerous boilers being in use in different vessels lying in the large port in which this explosion occurred, excited a good deal of apprehension, and stimulated the view that Government intervention was necessary for the protection of the number of people that frequented the docks. It is thought, however, that much may be done simply by faithful investigations, and plain-speaking verdicts, without any Government interference; and that if this course were generally adopted, which it unfortunately is not at present, the number of explosions would be materially reduced in the course of twelve months. At all events faithful investigation and truthful speaking should have a fair trial before Government interference is resorted to.

TABULAR STATEMENT OF EXPLOSIONS, FROM OCTOBER 27TH, 1866, TO NOVEMBER 23RD, 1866, INCLUSIVE.

Progressive No. for 1866.	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
50	Nov. 1	Double-flued Marine. Internally-fired	5	0	5
51	Nov. 3	Portable Locomotive type. Internally-fired	0	0	0
52	Nov. 5	Particulars not yet fully ascertained.................	0	0	0
53	Nov. 11	Single-flue or "Cornish." Internally-fired	1	1	2
54	Nov. 20	Plain Cylindrical. For steaming rugs. No fire	0	0	0
		Total..................	6	1	7

For the past month I have to report five explosions, by which six persons have been killed and one other injured. Not one of the boilers in question was under the inspection of this association. I visited the scene of the catastrophe of No. 53 two or three days after the explosion occurred, while I have obtained particulars of several of the others; but though they are of special interest, they have been received too recently to be included in the present report, but will be given on a future occasion.

No. 53 explosion occurred at half-past seven o'clock on the evening of Sunday, November 11th, and resulted in the instantaneous death of the engineman, as well as in serious injury to a lad standing near the boiler at the time.

The boiler, which was not under the inspection of this Association, was of the Cornish type, being internally-fired, and having a single furnace tube running through it from end to end. It measured about 16 feet 6 inches in length, while it had a diameter in the shell of 5ft. 9in., and in the furnace tube of about 3ft. 1in., the thickness of the plates, being in the cylindrical portion of the shell seven-sixteenths, in the flat ends half an inch, and in the furnace tube seven-sixteenths for half its length at the firing end, and three-eighths for the remainder at the back, while the stated pressure at which the safety-valve blew off was 62lb, as shown by a mercurial steam gauge of the double-column inverted-syphon class, the shorter leg of which has a larger diameter than the other. The calculation of the safety-valve, however, gives a pressure of nearly 80lb, since the valve had a diameter of from 4in. to 4½in., measuring to the bearing surface, while the proportions of the lever were 13 to 1, and the load at the end consisted of a ball weighing 67lb, as well as a weight of 13lb. Possibly, however, the weight of 13lb was not always applied, when the blowing-off pressure, as calculated from the safety-valve, would have been 67lb, which agrees pretty nearly with that stated to have been shown by the gauge. Safety-valves frequently commence to blow off at a few pounds below the pressure they should do according to calculation on account of the faces of the valve and seating not accurately fitting one another on the inner edge, which may arise either from the two faces not being at precisely the same angle, or from want of grinding to a true surface. It does not follow that a valve should leak under these circumstances, as it may be tight at the outer edge of the seat, though not at the inner one; but in consequence of this inaccuracy, the steam insinuates itself between the two faces, and thus operating on a larger area than that due to the accepted diameter of the valve, lifts it at a slightly lower pressure of steam than it otherwise would. Safety-valves with wide bearing surfaces are more liable to this inaccuracy than those with narrow ones.

The boiler failed at the furnace tube, which collapsed from one end to another, in a line a little to the right-hand side of the crown, rending away, for about a third of its circumference, from the flat end plates at the back and front of the boiler, while, in addition, a portion of the tube at the front end bulged upwards, until the plates at the top and bottom of the furnace met together. On the occurrence of these rents the steam and water rushed out from the furnace mouth, blowing a lad, who was the son of the owner, up into the air, and throwing him on to the roof of an adjoining building, while the engineman was altogether hurled out of the premises, and dashed against a dwelling-house in a street leading up to the works, his body being picked up in a terribly mutilated state, at a distance of upwards of one hundred yards from the firing-place in which he had been standing, in addition to which the boiler was thrown upon its side, its seating altogether destroyed, the house in which it stood brought down, and the works generally dismantled; while the *débris* was scattered in every direction, and some portions thrown to considerable distances, one of the bricks entering the room of an adjoining cottage, where it struck a man on the leg, who was ill at the time, and died on the following day. The pecuniary loss to the owner was considerable.

The explosion was not caused by shortness of water. This was clear on an examination of the furnace crown and a consideration of the character of the collapse. The plates were not bagged down at the furnace crown, nor more affected there than elsewhere, which they would have been had overheating from shortness of water occurred, but the top of the tube was flattened and distorted from end to end, while the bottom, as already stated, was bulged upwards at the furnace end, which could not possibly have been due to shortness of water, so that the cause of the explosion must be sought elsewhere. There appears to have been the greatest recklessness on the part of the attendant. He had but just taken charge of the boiler on the day of the explosion, and was firing-up on Sunday night so as to be ready for work on Monday morning, and seems to have been desirous to bottle up a great pressure of steam ready for use the next day, and therefore as soon as it commenced to blow off, at a pressure of 62lb. by the gauge, he tied first one brick on to the safety-valve, then a second, and ultimately a third, which, with the weights already described, would give a pressure of, as nearly as may be, 110lb. on the square inch. He was warned of the danger by a man standing by, who saw a pressure of 68lb. on the steam gauge, as he left the boiler-house just in time to escape the effect of the explosion. The pressure gauge only ranged up to 70lb., and as the column was an open one, the mercury would have been blown out if that pressure had been exceeded, and thus have left a witness of the fact, had not the engineman, as I am informed, shut a tap in the steam pipe between the boiler and the gauge, thus cutting off the connection between the two, and rendering the steam gauge inoperative.

Of the recklessness of the engineman there can be no question, and it cost him his life; but if the whole truth must be spoken with regard to this explosion, more must be said; in the first place, with regard to the incompetence of the attendant, and, in the second, the inefficiency of the boiler and its fittings. Culpable as the engineman clearly was, there are plenty of men to be had who are too well educated and too reliable to be so foolhardy as to blow either themselves or their master's boilers to pieces; and if it be objected that the employment of a superior class of men would necessitate a higher rate of wages, and thus increase the working expenses, it is thought that this may be fairly answered by contrasting the small outlay necessary to meet the rise of wages,

with the expense of such a catastrophe as the present, which laid the works in ruins. False economy is the cause of many explosions. With regard to the boiler and its fittings: had these been all they might have been, the explosion would not have happened. Every boiler should have a duplicate safety-valve. Had one of these been of the description adapted for blowing off when the water sinks below its proper level, and which are fitted with an internal weight, the attendant could not have gagged it without letting the steam down, taking off the man-hole lid, and getting inside the boiler, which he had no opportunity of doing; while if the second safety-valve had been of the external dead weight class, a few bricks added to the proper load would have had but little effect upon it. The difference between overloading a dead weight or a lever safety-valve must be obvious at a glance. Thus:—The proportions of the lever in the present instance were 13 to 1, so that every pound hung on to the end, put thirteen upon the valve, and the three bricks added 27lb. per square inch; while, with a dead weight valve of equal diameter, three bricks would only have added 2lb., so that it would take thirty-nine bricks to do as much mischief with the dead weight valve as three did with the lever one. Also three bricks may easily be tied on to the end of a safety-valve lever by a piece of string, as they were in the present instance, but it is not so easy to pile thirty-nine on to the dead weight valve, especially if carried up through the roof of the boiler house, as these valves frequently are, so as to be in nobody's reach without a ladder, and at the same time conspicuous to all. Both these dead weight* and low water safety valves† have been frequently referred to on previous occasions; hundreds are at work satisfactorily in different parts of the country, and many of the explosions met with would have been prevented by their adoption. With regard to the boiler itself, it may be added that the furnace tube was not strengthened either with flanged seams, encircling hoops, or other approved means; and had these precautions been adopted the boiler would not have burst as it did, at a pressure of 110lb. per square inch, while there is reason to doubt, judging from the direction of the collapse, whether the furnace tube was truly cylindrical, which it is most important should always be the case. Important, however, as these considerations are, the construction of the furnace tube has not so immediate a bearing upon this explosion as the question of fittings referred to above.

In conclusion, while there is no question as to the culpable recklessness of the engineman, and that it proved the immediate cause of the explosion, by leading to an excessive pressure of steam, yet it must be added that a well-made boiler, equipped as recommended above, and as many are, could not without difficulty have been blown up by the attendant, even if he desired to do so, while there are plenty of suitable men to be had, who would not blow up a boiler if they could. Superior attendance and superior boilers would prevent the recurrence of such explosions as the present.

LONDON ASSOCIATION OF FOREMAN ENGINEERS.

The fourteenth annual meeting of members of this society took place on the 5th ult., at its rooms, Doctors' Commons, City. Notwithstanding the inclemency of the weather and the fact that the residences of the members are widely separated from each other, the attendance was very large. The proceedings of the evening comprised the election of some six or seven new members, the discussion and subsequent unanimous reception of the auditors' report for the preceding half year, the reading of the president's annual address, the appointment of officers for 1867, and the completion of preliminary arrangements for the anniversary festival to take place on the 16th of February. From the auditors' report we extract the following financial summaries:—General fund, cash in treasurer's hands, Dec. 1st, 1866, £55 19s. 9½d.; amount in savings' bank, £60; to purchase of £400 in 3 Per Cent. Consols, £364 4s. 2d.; total, £480 3s. 11½d. Superannuation Fund, invested in purchase of £676 13s. in 3 Per Cent Consols, £609 9s. 10d.; brokerage, 17s. 2d.; total, £610 7s. Interest on £599 19s. for one year, £17 18s. 8d.; interest on £77 4s. for half year, £1 3s. 1d.; total, £629 8s. 9d. Messrs. Grint and Dewar were the auditors.

The figures may be said to represent a very favourable state of affairs, while it must be remembered that the allowance of £1 per week for sixteen consecutive weeks, if needed so long, to each unemployed member, constitutes in seasons of depressed trade like the present, a heavy item of expenditure. When this matter had been disposed of, the retiring president (Mr. Joseph Newton) proceeded to deliver his valedictory address, which, although far too lengthy for reproduction in our columns, comprised many interesting reflections and suggestions. After some preliminary remarks, the reader said that the society had now had an actual existence of fourteen years, although its conception dated as far back as 1851, when the Great Exhibition was in the height of its hitherto almost unparallelled success. It was at that period that Mr. George Sheaves, then a principal foreman to Messrs. George and Sir John Rennie, first expressed his ideas of the probable usefulness of such an institution. In conjunction with two or three other foremen in the same establishment, Mr. Sheaves made the rough draught of rules for the government of a foreman's association, and this was done after working hours, in an office on the premises of Messrs. Rennie. The factory of those gentlemen was, therefore, the birth-place of this society, and their employés were its parents. The first recruits to the ranks of the young institution were four or five foremen from Woolwich Arsenal, and two or three from Messrs. Grissell's works at Hoxton.

The primary assemblage of members for the despatch of business took place at an inn known as the "Founders' Arms," in Holland-street, Blackfriars-road, a singularly appropriate place, for several of the associates were ironfounders, and all were unquestionably founders of the society. Subsequently the meetings were held alternately at Woolwich and in London for the convenience of members living in both places, and it is on record that, as a general rule in either case, there were no absentees. It was impossible not to admire the zeal and devotion of that little band, and to their energy and perseverance it was due that the society eventually became a great success. Had those pioneers been faint-hearted, the institution would not now be strong, and might not, indeed, have preserved its vitality at all. He was glad to see at least two of these gentlemen, Messrs. Keyte and Ross—present that evening.

It was not (said Mr. Newton) his intention, at least on that occasion, to trace the onward and upward progress of the Association of Foreman Engineers from the small beginnings to which he had referred to the present time. Possibly that might one day be done, and then a chapter or two might well be devoted also to those vigorous offshoots from the parent stem—the Manchester and the Leeds associations. They also had their founders, self-denying and earnest men, and who deserved honourable mention.

Mr. Newton next glanced at the actual condition at this moment of the engineering trade in London, and said that he considered the question of its apparent declension to be one pregnant with interest to both honorary and ordinary members of their society. Into the causes of that declension, and whether or not it would be of temporary or permanent duration, it was not his intention to go. The laws of the association explicitly deprecated interference on the part of its members with "trade politics," and it was not for him to violate the wholesome injunction. It seemed, nevertheless, that the period had arrived when they should, as a matter of self-preservation, almost endeavour to strengthen the ties which bind together the interests of all grades of the engineering profession in the metropolis. Perhaps he might be permitted to suggest that a friendly Conference between employers and foremen would be serviceable in the elimination of plans for the resuscitation of the declining trade and the advantage of all concerned. In spite of the depression without, it was consolatory to know that the association was prospering within, for the year just closed had witnessed a large accession—about thirty, he believed—of new members, a sensible increase in its funds, few associates unemployed, and not a single death in its ranks. The total number of members on the books that evening was something over one hundred and fifty. Among these he was pleased in being able to say there were many eminent employers of engineering labour. It was gratifying, too, to have found the past year so prolific of valuable papers and instructive discussions. These agencies were the levers by which the institution would be raised still higher in public estimation, and in publishing so constantly the reports of their proceedings, The Artizan and other scientific journals had entitled themselves to its thankful acknowledgments. He (Mr. Newton) wished that members would throw off that reserve and diffidence which, far more than any lack of ability prevented them reading papers and introducing subjects of a practical kind for deliberation. Such subjects were abundant, and in order to demonstrate this he would enumerate some twenty or thirty, for some of which he was indebted to his friend, Mr. W. S. Worssam. This list was read, and it included points in almost every branch of mechanical engineering. Their friend, Mr. G. F. Ansell, had promised a lecture at their March meeting, on the "Physical Properties of the Gases," a subject which he (Mr. Newton) was assured would be found full of interest, and which would be ably handled by that gentleman.

At much length the president then referred to the disastrous accidents at the Barnsley and Staffordshire coal pits. It would be well if such societies as their own paid more attention to the question of colliery working, and attempted a solution of the problem how to raise the greatest quantity of coal with the least cost of life and limb. * * Returning to their own society, he had stated that no death had occurred during the year 1866; but he might state that two members who had seceded from its ranks—Messrs. William Muir and Josiah Glasson—had unfortunately died. The first had been an office-holder in the society, and was distinguished for talent, modesty, and single-mindedness; the second had also gained the respect of his fellow members, and both were much regretted.

A proposition for extending to the members of the society an advantageous system of life insurance was explained by Mr. Newton, who then, after acknowledging repeated acts of kindness, constant support, encouragement, and much forbearance on the part of every member of the association, formally resigned the presidential chair and retired from the assembly room.

Mr. Newton was afterwards unanimously re-elected as president, Mr. W. H. Keyte being chosen vice-president, and Messrs. Sanson, Edmonds, and Irvine, as committee-men. Some business of minor importance brought the meeting to an end.

ON THE RECENT PROGRESS OF INDUSTRIAL CHEMISTRY.

By G. Stevenson Macadam, Ph.D., F.R.S.E., F.C.S., Lecturer on Chemistry, Edinburgh.

We gladly find room for the following *resumé* of the recent progress of industrial chemistry, in the shape of a discourse, delivered by Dr. Stevenson Macadam before the Scottish Society of Arts at Edinburgh:—

The progress of every department of science at the present day is so rapid that it becomes a difficult task for even professional men to keep pace with the times; and this remark applies with greater force to the science of chemistry than probably to any other.

No branch of knowledge has made more rapid progress in modern times; and, connected as chemistry undoubtedly is with many other departments of science,

* See in The Artizan Association's Monthly Reports. November, 1864, No. 30 Explosion. January, 1866, No. 6 Explosion. May, 1866, No. 21 Explosion. October, 1866, No. 29 Explosion.

† See remarks in The Artizan under "Injury to Furnace Crowns through shortness of water," in Association's printed Monthly Report for October, 1863; January, 1865; April, 1865; and May, 1866. Also No. 8 Explosion, February, 1866.

such as physiology, geology, and botany, and with the majority of the arts and manufactures, it will be at once apparent that a review of the progress of chemistry, which would embrace all its ramifications, would be a lengthy and laborious task. My duty this evening will be to lay before you such a *resumé* as will enable you to observe in a general way how rapid the steps and how lengthened the strides have been, which chemistry has taken within the last few years.

In the prosecution of the sciences, and the adaptation of the discoveries which are made for the benefit of mankind, three classes of workers are diligently pursuing their labours:—

First—Those who have time and means at their disposal to make researches into unknown regions, and who elaborate therefrom new compounds and new doctrines.

Second—Those whose special province it is to arrange the discoveries made, and by their teachings to impart a knowledge of the facts and principles of the science to others in a clear and tangible form; and,

Third—Those who, connected with the arts and manufactures of the country, seize hold of new things, and practically work them into material specially suitable for the age we live in.

The present time is particularly applicable for a discourse on the progress of chemistry, not only on account of the many discoveries of new substances, and their novel application in the arts, but also from the fact that we are on the threshold, or, rather, I should say, we have but lately passed the threshold of a change in the symbolic representation of chemical substances, and the groups they form, which must lead to much change in our chemical treatises, our chemical teaching, and our chemical examinations.

The new views have an important bearing on the advance of the science, and they already occupy a conspicuous part in the representation of the constitution of compound substances. I will take occasion, at the close of this discourse, to refer shortly to the more important doctrines recently being worked out, but which are apparently still merely the germ of what will follow, so that, as the change proceeds, and the new views germinate and are developed, we may be prepared in some measure for them.

During the last few years, two new modes of analysis or methods for the investigation of substances have been discovered, and have been applied to the examination of materials. One of these processes is the separation of chemical substances from each other, by allowing solutions containing such to pass through a diaphragm or septum, and has been styled Dialysis; whilst the other method of research depends upon the production of certain lines or bands by the various elementary bodies, when these or their compounds are burned in a flame, and the light is then decomposed by a prism, so that the spectrum is obtained. The latter mode of research is termed Spectrum Analysis.

The various researches in Diffusion Analysis have been worked out by Professor Graham, Master of the Mint; and the well-known investigations undertaken by that distinguished chemist in regard to the diffusion of gases, supplied us years ago with the laws regulating the passage of the various gases through each other, either in a common atmosphere or through porous plates. The later researches on diffusion have reference to liquids and the substances dissolved therein. Certain liquids have no power of diffusing through each other, such as mercury, water, and oil, which, when mingled together, arrange themselves according to their densities; and thus the mercury remains at the lower part of the vessel, the water in the middle, and the oil floats above. Agitation of the liquids may cause a momentary intermingling of the substances, but subsequent quiescence will enable the mercury, water, and oil to separate again from each other, and arrange themselves as before. When water and alcohol are taken, however, and cautiously introduced into a vessel, so that the water may remain at the lower part and the alcohol is above, it is found that the two layers of liquid gradually intermingle; and in the course of time the water will rise in part through the alcohol, whilst the latter descends in part into the water layer; and at length the two substances, which were at first separate, will have become so thoroughly intermingled that there will be as much alcohol below as above, and the liquid will form an uniform mixture.

The diffusion of liquids may be observed by various arrangements, but the simplest apparatus is a tall glass jar, which is nearly filled with water, and to the lower part of which a solution of the substance to be experimented upon is carefully introduced by a long pipette. The saline matter in the lower stratum begins to rise slowly through the upper water, until in some instances it can be recognised at the summit of the column of water; whilst in other cases the process of diffusion proceeds so slowly that the material scarcely finds its way half up the water column, in the time which has enabled other materials to reach the top layer of water. Professor Graham has made an elaborate series of observations on the whole subject; and arranging that the conditions of the experiments were similar, and the temperature as nearly as possible uniform during the continuance of the trials, he has determined the approximate time required for the same degree of diffusion of many substances through water. Hydrochloric acid was found to be one of the most rapid in its rate of diffusion, succeeded by saline substances; and the slowest in diffusing themselves throughout the water were such bodies as albumen and caramel. Thus, whilst hydrochloric acid diffuses itself throughout the upper column of water in a time represented by 1·00, chloride of sodium will take 2·33, sugar 7·00, sulphate of magnesium 7·00, albumen 49·00, and caramel 98·00, or nearly 100 times the period required for the diffusion to the same rate of hydrochloric acid. The difference in the rapidity of diffusion has suggested the possibility of separating, to some extent, substances from each other, as in a mixture of chloride of sodium and sulphate of magnesium, where the former would tend to diffuse through upper layers of water at a rate three times quicker than the latter. Professor Graham has suggested that the substances which have a quick rate of diffusion should be called *volatile* or *crystalloids*, the latter term indicating that crystalline bodies have a ready diffusibility; whilst the substances which are tardy in their rate of diffusion should be styled *fixed* or *colloids*, the latter term being used owing to gelatine (collin) being representative of the class. A modification of the experiments in jar diffusion may be carried out, by placing the substance to be experimented upon in a phial, and introducing such into the lower part of a tall jar containing water, when a similar series of results will be obtained to those already referred to.

The special department of diffusion which is properly termed dialysis, has reference to the separation of substances dissolved in liquids by means of allowing them to pass through a diaphragm or septum. Various membranes will serve for the diaphragm, such as a bladder or part thereof, but the best material for the purpose is parchment paper. This material was first prepared by M. Gaine, and afterwards by De la Rue, and it is most easily formed by taking a mixture of one part by volume of water, and adding thereto exactly two volumes of oil of vitriol. When this acid mixture is allowed to cool, and ordinary bibulous or unsized paper is soaked therein, the paper undergoes a molecular change, becoming transparent to a certain degree, and when washed in dilute ammonia to neutralise the acid, and thereafter in a stream of pure water, and subsequently dried, the bibulous paper has been manufactured into parchment paper. This peculiar form of paper is tough even when wet, and very much resembles in general appearance a piece of ordinary parchment. The proportions of acid and water employed in its preparation require to be very exact, as a larger quantity of either acid or water will destroy the paper and convert it into a pulpy substance. Instead of using oil of vitriol and water in the preparation of the parchment paper, Mr. T. Taylor has suggested the use of a strong solution of chloride of zinc, which acts in the same way. In employing the parchment paper as a dialyser, the paper is placed between two hoops of gutta-percha or other material not readily acted upon, in the same manner that an ordinary sieve is constructed, or the parchment paper is firmly tied round the open mouth of a small bell jar shaped like an inverted cup, and having an opening at the upper part through which the liquid may be introduced into the bell jar or bulb.

The substance to be dialysed is placed in the upper part of the diaphragm of parchment paper, and the apparatus called the dialyser is then floated on the surface of water contained in a vessel placed below. Certain substances, especially those of a crystalline nature, such as metallic salts, arsenious acid, sugar, strychnine, morphia, and quinine, pass through the diaphragm of parchment paper into the water underneath with considerable rapidity, and the bodies of this class are styled crystalloids. Other materials, however, such as gelatine, albumen, pectin, animal mucus, vegetable gelose, and caramel, pass through the dialysing membrane very tardily, and are named colloids. As a class, the crystalloids are more or less sapid to taste, whilst the colloids are more or less insipid. When a mixture of a crystalloid, such as arsenious acid, and a colloid, such as gelatinous matter, is taken and placed on the dialyser, the crystalloid or arsenious acid passes comparatively rapidly through the diaphragm, whilst the colloid or gelatine is left in a greater part on the upper side of the septum, and thus the process can be successfully followed in the separation of substances from each other. Thus, arsenious acid may be readily dialysed from the albuminous and other organic ingredients present in the stomach of an animal which has been killed with that poison; and in employing this mode of analysis in the separation of poisons from organic mixtures, it is interesting to observe that all the organic and inorganic poisons are crystalloids, and hence tend to pass readily through the diaphragm. Professor Graham has taken a mixture of a solution of arsenious acid and albumen, and having coagulated the albumen by heat, he has dialysed the arsenious acid out of the mixture to the extent of four-fifths of the entire amount of the poison. In a mixture of arsenious acid and porter, which was thrown on the dialyser, the poison passed through the membrane, accompanied by a faint yellow colour, which stained the water, and at this stage one-half of the arsenious acid had been dialysed from the porter mixture. This common poison has likewise been separated by this process from blood, the contents of the intestines, &c. My late assistant, Dr. Alexander T. Machattie, a Fellow of this Society, has suggested that, in cases of poisoning, the stomach, or the intestines, or both, might be simply secured at the openings, and the organs with their contents, be placed in a vessel of water when the crystalline poison would dialyse through the membrane of the coats of the stomach or intestines, and pass into the water, which might then be examined. This operation might be carried out as a preliminary operation in cases of poisoning; and it would have this manifold advantage, that an indication of the poisonous ingredient might be obtained without actually disturbing the contents of the stomach or intestines, and without removing them from these organs. Mr. Whitelaw, of Glasgow, has suggested that the large quantities of brine from salted meat, which are at present thrown away, might be utilised by being subjected to the process of dialysis. He proposes to place the brine from the salted meat in bladders provided with stopcocks, and to suspend these bladders in a tub or tank of water. The crystalloid chloride of sodium will quickly pass through the membrane of the bladder, and in a few days the contents of the bladder will be found comparatively free from salt, which will have passed into the water in the tub or tank, whilst the extract of meat which possesses colloid properties, will have remained behind in the bladder and may thereafter be utilised as extract of meat or beef-tea.

The importance of the process of dialysis in the physiological changes which occur in the animal economy can hardly be over-estimated. Many of the changes in the position of the matter of the living economy, as in the diffusion of substances through the animal system, must be regulated or influenced by dialysis. In pharmaceutical operations, it is worthy of consideration how far dialysis might be employed in the separation of crystalline substances from their source, as strychnine from nux vomica. In many geological phenomena, as in the infiltration of substances into rocky cavities, dialysis no doubt plays an active part.

The second mode of investigation which the recent progress of chemistry has placed in the hands of man is spectrum analysis, or the determination of the ingredients of a substance by the various lines or bands which it may produce when it is burned in a flame, and the light evolved therefrom is decomposed into its rainbow tints. The admirable researches of Bunsen and Kirchhoff have contributed the greater part of our knowledge on this important branch of the science, and have formed the key-note to the department of celestial chemistry. What the microscope is to the physiologist, and the telescope is to the astronomer, the spectrum apparatus or spectroscope is to the chemist. It supplies a most searching and delicate mode of analysis, and serves to indicate the presence of substances in quantities where, in some instances, they do not exceed 1-100,000th of a grain.

Spectrum analysis has already revealed the existence of four new metals, which probably, except for this mode of examination, would have still remained unknown even to scientific men. Bunsen was successful in discovering cæsium and rubidium, Crooks discovered thallium, and Reich and Richter were fortunate enough to make the most recent discovery of the metal indium. The credit of the practical application of the spectrum apparatus belongs to Bunsen and Kirchhoff, and they led the way in the detection of new substances.

The new metal, cæsium, was first discovered in the Dürckheim mineral spring, 100 gallons of which yield about a grain of the metal, which is about the proportion of a ton of the water yielding two grains of the metal. It has also been found in other mineral springs; and, through the kindness of Professor William A. Miller, of King's College, London, I have here a minute quantity of a compound of cæsium, obtained by him from the Wheal Clifford hot-spring in Cornwall. Cæsium has also been found in certain minerals, such as lepidolite, which contain merely traces, as generally obtained, but one sample of the latter mineral, brought from the state of Maine, had 0.24 per cent. of the new metal and a rare mineral, called Pollux, has yielded 32 per cent., and is the most extensive source of cæsium at present known. Cæsium is recognised by giving two bright blue lines in the spectrum.

Rubidium was also discovered by Bunsen and Kirchhoff in the Dürckheim mineral spring, and is present in larger quantity than the cæsium. It is also found in other spring waters, and in several minerals, including lepidolite. It is characterised in the spectrum by giving two violet lines and two red lines. I am indebted to Professor Roscoe of Manchester for the sample of chloride of rubidium which I now exhibit.

Thallium was discovered by Crookes in certain sulphur ores, and is most easily obtained from the flues attached to the burners of the sulphuric acid chambers where pyrites are employed. The thallium gives a beautiful bright green line or band of intense brilliancy. I have a sample of the metal of considerable size, which I now exhibit, and a large specimen of the crude chloride of thallium. The metal is very dense, and much resembles lead in general appearance.

Indium was first detected by Reich and Richter, but has been more fully investigated by Winkler. It is obtained from zinc-blende, especially from that employed in the Freiberg mines. The metal zinc obtained at these works contains traces of lead, iron, arsenic, cadmium, and 0·0448 per cent. of indium. It is a white metal, resembling platinum in general appearance, but is soft like lead, with which it has a similar fusing point, and marks paper when pressed upon it. It is not oxidised by the air, and at a red heat, it burns with a violet blue flame. The spectrum of indium gives a decided indigo blue line.

Spectrum analysis has not only yielded discoveries in terrestrial matter, but it has likewise done good service in the examination of the constituents of the other planets, and also of the sun and stars. The researches on this subject have been principally made by Huggins and W. A. Miller in England, Cooke in America, Donati in Italy, and Father Secchi in France. Jupiter and Saturn possess atmospheres which contain some gases and vapours similar to those present in the atmosphere of the earth, but others are not identical. In Mars, the lines which are observed as characteristic of Jupiter and Saturn are not to be found, whilst in Venus all the lines of the solar spectrum can be seen. The general result of the observations on non-terrestrial orbs is, that there is a community of matter in the visible universe, and that whilst our sun, the centre of our planetary system, has been demonstrated to contain many of the elementary substances found on the earth, other stars have also been found to be composed, in part at least, of the same elements. Thus, the star Aldebaran has been shown to contain sodium, magnesium, hydrogen, calcium, iron, bismuth, tellurium, antimony, and mercury.

Advantage has been taken of the powers of the spectrum analysis to indicate the presence of blood-stains, and even the quality of that blood. Thus, Hoppe and Stokes have shown that when blood mingled with water is placed in a tube, and a ray of light is transmitted through the liquid, and thereafter through a prism, the spectrum which is obtained exhibits a number of dark bars or spaces which are bands or lines of absorption. These vary according as the blood is arterial or venous, and many different series of bands have been obtained. It is suggested that this method of research might be resorted to in investigations on the blood in health and disease. Sorby has applied these observations to the detection of blood-stains in criminal cases, and has contrasted the colouring matter with cochineal, cudbear, &c. The blood in its various stages of oxygenation has been found to yield eight different spectra, four or five of which are quite distinct from everything else.

In metallic chemistry several novel points have been recently brought to light. The researches of Deville and Troost have shown that, at high temperatures, the metals are permeable to gases. Platinum and iron, when raised to a white heat, are so easily permeable that hydrogen passes readily through sheets of the metals; and in the case of platinum of one-twelfth of an inch in thickness the gas can be passed through under the ordinary pressure of the atmosphere. Stahlschmidt has announced that pure iron, which he has been the first to prepare, is a silver-white metal, and is so soft that it can be cut readily with an ordinary knife. The conversion of cast-iron into steel by the rapid process of Bessemer is now carried on a most extensive scale in England, and likewise in Glasgow, at the Atlas Works, belonging to Messrs. Rowan and Co., who have kindly forwarded to me a most complete series of specimens illustrative of the whole process. The principle involved in this operation is to rid the cast-iron of carbon and other impurities by subjecting it, when in a molten state, to a powerful blast of air, which burns away the greater part of the extraneous matters; thereafter, a small proportion of a German iron called Spiegeleisen, and which contains much carbon, is run in amongst the molten and purified iron which thus acquires sufficient carbon to give it the chemical properties of steel; and on pouring out the molten matter into moulds, blocks or ingots of steel can be procured of greater or less weight and size. In this manner, the lengthened processes of converting cast-iron into steel, which even yet are resorted to, and which comprise the tedious puddling operations, with the subsequent action of the steam-hammer and numerous rollers, and, lastly, the cementation process of baking the bar-iron for days surrounded by charcoal, are dispensed with, and within a tithe of the time ordinarily employed, the cast-iron is converted into Bessemer steel, which only requires the steam-hammer and rollers to fit it for many important purposes. Bessemer steel is now superseding ordinary steel in many ways, and, doubtless, from the rapidity with which tons of this steel can be manufactured, there is every reason to believe that it will come into use for many purposes where ordinary steel, from its comparative high price, could not be employed.

A highly ingenious application of cast iron to filling in thin moulds of brass copper, bronze, &c., has recently been brought out by Mr. Atkin, of the firm of Messrs. Winfield and Co., Birmingham. The very high temperature of molten cast iron would cause the destruction of any thin mould of copper, brass, or bronze, were the cast iron poured into the mould in the open air; but by immersing the thin mould in water, so that it shall be surrounded by the water, and then pouring in the cast iron, the latter, in heating the metal of the mould, merely conveys heat to the outer film, which is immediately imparted to the water, and thus the mould is kept from being damaged or even tarnished. This process of filling in a mere shell of a more expensive metal with cast iron is eminently suited for the preparation of weights for ordinary beams or for gas lustres, for giving solidity to electrotypes of figures or statuettes, for stair rails, metal bedsteads, door handles, &c., and, indeed, wherever iron can be employed, and which, by this process, can be coated with a thin covering of a more costly metal, and thus acquire the appearance of being solid brass, bronze, or copper.

A new method of coating iron with copper has been suggested. The iron is plunged into a boiling solution of a compound of copper with an organic acid, such as the double tartrate of copper and potass, with excess of alkali, and holding the iron article with a brass wire during the time of immersion. The iron is lifted out of the bath with a greater or less thickness of copper, according to the time in which it has been immersed in the copper solution. The investigation as to the presence of phosphorus in metals has led to the determination of two points: that a very minute proportion of phosphorus in copper wire lessens its power for the transmission of electricity, and consequently for the conveyance of telegraphic messages; and that the presence of one-eighth to one-half of a per cent, of phosphorus in copper imparts much greater tenacity to the copper, and renders it much more fit for the manufacture of tubing.

The metal magnesium continues to be manufactured in quantity, and the vividness and intensity of the light evolved during its combustion have been determined with much accuracy. The light has been observed at a distance of twenty-eight miles, and, considering the production of light over a period of ten hours, it has been observed that two and a half ounces of magnesium, in burning, give out as much light as would be obtained during the combustion of seventy-four candles for the ten hours, and which would involve the consumption of twenty pounds of stearine. A curious point regarding the combustion of magnesium is, that it burns as readily in carbonic acid gas, which immediately extinguishes ordinary lights, as it does in common air.

A white gunpowder has been announced by Schultze. A sawdust is prepared by cutting cross veneers from logs of wood, and crushing these into powder. The material is then boiled for several days in a solution of soda, which is renewed from time to time, when the residual matter is washed with water, steamed for fifteen minutes, and washed again in water for twenty-four hours. The sawdust can then be bleached with chlorine or bleaching powder, thereafter boiled with water, washed, and dried. In order to act upon this sawdust, a mixture of 40 parts of fuming nitric acid (sp. gr. 1840 to 1900) and 100 parts af sulphuric acid (sp. gr. 1840) is made up and allowed to cool, by standing two hours or so. 100 parts of the acid mixture are placed in an iron vessel, surrounded by cold water, and six parts of the sawdust are well stirred throughout the acid, and allowed to remain in contact therewith, with repeated stirring. The whole is then placed in a centrifugal machine, during the revolution of which the excess of acid is separated, and the sawdust is then subjected to a process of washing in cold water during several days, immersed in a dilute solution of soda to neutralise the remaining traces of acid, again washed with water and dried. The sawdust is finally treated with a solution of 26 parts of nitrate of potassium in 220 parts of water, and dried at a temperature not exceeding 111° Fahr.; after which, the fine dust can be separated by a sieve. The white gunpowder thus prepared, and which is in reality a gun-sawdust, possesses highly explosive and great propelling powers.

A cheap blasting powder has been recommended, in which part of the nitrate of potassium of ordinary gunpowder is replaced by nitrate of sodium. The proportions employed in the manufacture of the new blasting powder are, nitrate of potassium 57 parts, nitrate of sodium 18 parts, charcoal 15 parts, and sulphur 10 parts. The cheapness of this powder is its recommendation, but there is a probability of its absorbing damp from the atmosphere.

A highly explosive oily substance, called nitroglycerine, with the composition $C_6H_5O_3(NO_5)_3$, has been discovered. When used for blasting, the bore or hole is made water-tight, the nitroglycerine is run in, and thereafter some water, and

the oil is lighted by a fuse. One volume of the oil when exploded evolves 1,300 volumes of gas, which consist of steam 554, carbonic acid 469, oxygen 39, and nitrogen 238. Weight for weight, the nitroglycerine is said to be five times more effective than ordinary gunpowder.

In the waterproofing of cloth, Dr. Stenhouse has suggested that paraffin might be employed with great advantage. Previously, for the thorough waterproofing of the cloth, caoutchouc and gutta-percha had been used, and for the partial waterproofing, beeswax and linseed or other drying oils had been employed, accompanied by oxides of lead and manganese as driers. The cloth when treated with the latter mixtures, allowed the rain to fall off, without materially wetting the cloth; whilst at the same time the textile fabric was porous, and admitted of the ready passage of vapours, such as the perspiration from the body of the animal. This oily coating on the cloth, however, was liable to oxidation, and in time lost to some extent the property of being impervious to water. Dr. Stenhouse's patent suggests the employment of the solid paraffin, accompanied by a small percentage of linseed oil; and the cloth which can be rendered water tight by this mixture may be of any description and texture, such as cotton, linen, woollen, &c. Such cloth, impervious to rain, would be highly serviceable in the construction of tents and in the covering of packages, as well as in outer garments; and the protecting mixture has the advantage of wearing well, and of not being liable to oxidation or decay.

In the preservation of museum specimens of decaying skulls, bones, &c., M. Stahl has proposed that melted spermaceti should be brushed over the firm specimens, whilst the more decayed and more fragile might be immersed in a fused mixture of 4 parts of spermaceti and 1 of colophony resin. It has occurred to me that solid paraffin might be advantageously employed for this purpose. Ancient stained glass, the obscuration of which has now been shown by E. Chevreul to be due to the adhesion of smoke, earth-dust, and other matters, can have its original colours revived with all their early freshness by steeping the glass in a solution of carbonate of sodium of sp. gr. 1068, for a few days, and thereafter for a few hours in dilute hydrochloric acid of sp. gr. 1080. When the glass is subsequently washed in water, the colours come out as pure as when the stained glass was first manufactured.

In sanitary chemistry much progress has been recently made. The examination of the air in many places has been carried out by Dr. Angus Smith, of Manchester, who has already published a most elaborate series of observations on the proportions of oxygen and carbonic acid in the atmosphere in town and country districts, on the top of hills, and in the depth of mines. Dr. Smith has brought out a most simple and ingenious instrument, consisting of a small bottle with a valvular arrangement, for the estimation of the carbonic acid in the atmosphere of any locality. A measured quantity of baryta water is placed in the bottle, and by means of a small india-rubber ball, which is attached to the bottle by a short length of tubing, and which can readily be compressed by the hand, air can be drawn through the baryta water; and according to the number of times that the ball requires to be compressed before the air has imparted enough of the carbonic acid to the baryta water to cause the appearance of a distinct precipitate, the purity or freedom of the atmosphere of the district may be determined. The more largely contaminated the air happens to be with carbonic acid, the fewer the number of compressions of the india-rubber ball which are required to supply the carbonic acid requisite for the fulfilment of the test.

The purity of the water supplied to towns and mansions for dietetic purposes has occupied much of my attention for several years. The impregnation of the water by organic matters of the nature of sewage does not only lead to the presence of such organic matter in the water, which at times can be readily detected by the senses of sight, and taste, and smell; but in the greater number of cases the water appears clear, possesses a good agreeable taste, and exhibits no odour. At such a stage the organic matter has in good part become so thoroughly decomposed as to lead to the formation of nitrates, which are dissolved in the water. In this state, the water will be found to be robbed of much of the oxygen gas which is dissolved in all fresh and healthy waters, and besides being unwholesome from the presence of the organic matter and nitrates, and the diminution of the oxygen gas in solution, the water, from the presence of the nitrates, has acquired the power of acting more or less powerfully on lead, so that it becomes dangerous to transmit it through lead pipes, or store it in lead cisterns. Water, therefore, when contaminated with organic matters, is liable to be doubly unwholesome from the impurity present, and the power which that impurity may confer upon the water to dissolve lead to a dangerous extent. A most ingenious apparatus for the distillation of water from sea water, or even from partially foul water, has been patented by Chaplin of Glasgow; and this distillærator not only admits of the distillation of pure water, but also supplies to the water the air which is found dissolved in all wholesome waters. The importance of such an instrument in ocean-going steamers and sailing vessels, and in all positions where there is a practical difficulty in procuring or providing good water, can hardly be over-estimated.

The various disinfectants and deodorisers which may be employed in rendering less powerful the odours evolved from decomposing organic matter in cesspools, drains, &c., have lately received special attention. The most important of these agents is chloride of lime or bleaching-powder, which, in the proportion of one pound to the 1,000 gallons of sewage, proves itself a valuable and true disinfectant. The permanganate of potassium, or Condy's fluid, is likewise serviceable in treating sewage, but is principally of value in the disinfecting of clothes, which lose all disagreeable odour when treated with the fluid, and at the same time the fibre of the cloth is not injured. M'Dougall's disinfecting powder, which mainly owes its efficacy to carbolic acid and sulphurous acid, removes instantly the offensive odour of sewage, and portions of this powder strewn over the floor of stables, byres, &c., quickly renders the atmosphere of such places untainted by ammonia or other gases. A room in which a patient is located, who is suffering from disease giving rise to offensive effluvia, may have its atmosphere much improved by introducing a vessel containing some of this powder. Solutions of chloride of zinc, chloride of manganese, and perchloride of iron with more or less water, are serviceable in fixing all odorous effluvia during the emptying of cesspools, &c. Charcoal, when strewn over decaying and putrefying matters, hastens their decay, and at the same time absorbs the gases. When the charcoal is associated with earth, its employment may be practically carried out. Quicklime, when treated with water and used for white-washing the walls and ceilings of rooms which have been inhabited by parties labouring under infectious diseases, or where much overcrowding has occurred, does good service in the destruction of any organic matters which may be lodging there. The mere application of heat, ranging from 210° to 250° Fahr. to woollen bedding or clothes and other articles, destroys any infectious matter which may contaminate them.

The large amount of sulphur which is burned off from the metallic ores in Swansea and elsewhere, and which escapes into the atmosphere as sulphurous acid, and thereafter becomes, in part at least, sulphuric acid, has recently called forth the attention of scientific and practical men. In the neighbourhood of works discharging such sulphur smoke, the ground is barren, scarcely any vegetation can be seen for miles, and even high chimney-stalks are of little avail, as they merely carry away the sulphur-smoke and distribute it over a wider and more distant area. One extensive firm of copper-smelters discharge in this manner into the atmosphere about 1,000 tons of sulphuric acid every week; and it is estimated that annually there are burned off from the copper ores worked in Swansea about 70,000 tons of sulphur, of the value of £455,000, and which might produce no less than upwards of 210,000 tons of sulphuric acid of the strength of oil of vitriol. Many of the manufactories of sulphuric acid have begun to use the copper ore as a source of sulphur, and thereafter hand over the roasted ore to the copper-smelter at Swansea. The raw ore contains about fifty per cent. of sulphur, and when roasted there are only left about four or five per cent. The ore is obtained in large quantities from the Guadiana river, Port Pomoron, in Portugal, from mines which were worked by the Romans, and it is used extensively for making sulphuric acid in London, Newcastle, Bristol, and other places. This is an excellent instance of the successful and economic employment of a material in the arts and manufactures, which was, till lately, and in many places still is, a nuisance over extensive tracts of country. The sulphur smoke in a very modified condition occurs in all large towns where much coal is burned, and especially in manufacturing towns, where the coal is often of inferior quality. In such towns, by the mere burning of the sulphur in the coals, many gallons of sulphuric acid must be formed, and in rainy weather be washed down on the umbrellas and clothes of the people.

The aniline or coal-tar colours have now been extended in number, so that all colours of the rainbow and all shades can be obtained from coal-tar. Aniline was discovered by Unverdorben in 1826, who procured it by the destructive distillation of indigo. It is now obtained in small quantity directly from the destructive distillation of coal, as in gasworks, but is generally manufactured from the lighter coal-tar naphtha. When the naphtha is rectified, the portion which distils over at a temperature of 180° F. is benzol, and this substance was discovered by Faraday in 1825. By the action of strong nitric acid, the benzol is converted into nitro-benzol, and the latter, when agitated with water, acetic acid, and iron filings, becomes aniline. By the action of oxidising agents, such as chloride of lime, bichromate of potassium, chloride of mercury, &c., the aniline, which is colourless by itself, can be transformed into all shades of violet, mauve, magenta. By the researches of Hofmann the number and beauty of the aniline colours have been much increased. Whilst numberless shades of reds and purples can be obtained, there is a splendid green called verdine, discovered by Eusebe, which remains a true pure green even by candle or gas light, and there are also a blue which is as clear as opal, a good yellow, and a fair black. In short, dyes of all hues can be obtained from aniline, which, in its turn, is procured from coal-tar. The intensity of these aniline colours may be indicated by the fact, that one grain of magenta in a million of water gives a good red; one grain in ten millions of water exhibits a rose-pink; one grain in twenty millions communicates a blush to the water; and one grain in fifty millions tinges the water with a reddish glow. The powerful tinctorial virtues of these dyes may be learned from a circumstance which occurred during the passage of the *Great Eastern* between Liverpool and New York, when the sea was observed to exhibit a crimson hue for some distance around the steamer, and when it was afterwards discovered that the bloody sea owed its colour to a wave having stove in a plate of the *Great Eastern*, and the sea having thus got access to certain vessels which contained magenta.

The action of two organic substances on the animal economy has received special attention from scientific men, on account of the startling power which they possess in evolving vapours which are highly poisonous. In 1860, a workman was engaged in handling a vessel containing nitrobenzol, when some of the liquid was spilt upon his apron. Not suspecting any ill effects therefrom, he breathed the vapour arising from the liquid on the apron, and in four or five hours he began to feel unwell, and in nine hours he was dead. Five cases have occurred where a few drops of nitrobenzol have been taken accidentally into the mouth, and four of the cases died. It is a powerful narcotic poison, and the patients feel drowsy, have convulsions and coma, and death ensues. A small dose of nitro-benzol given to an animal may take three or four days before the poisonous action is developed, and in one case the death of the animal did not occur for nine days. Aniline closely resembles nitro-benzol in its poisonous properties, but the salts of aniline are said to be harmless. Nearly an ounce of salt of aniline has been given to a patient within a few days, and no serious effects were observed.

A still more mysterious agent of destruction is presented to us in mercuric methide. This substance is prepared by placing ten parts of iodide of methyl, one part of acetic ether, and some sodium amalgam in a flask, where the materials are heated and then cooled. Thereafter the mixture is distilled, and the water being separated, the acetic ether removed by alcoholic potass, and the remainder washed with water, the mercuric methide is obtained. This substance

contains more than 80 per cent. of mercury, and its vapour has a most remarkable and injurious effect on the animal system. A chemical assistant, thirty years of age, and who had for ten years been engaged in investigations, was employed for three months in the preparation of mercuric methide, and must apparently have inhaled portions of the vapour. He began to suffer from impairment of sight, was thereafter seized with numbness in the hands, deafness, and great general weakness. His gums became sore, swollen, and tender. He moved his limbs slowly, and spoke indistinctly. He was removed into hospital, but his case got worse and worse. The breath and the whole body evolved an offensive odour; the patient became maniacal, and died in fourteen days from his admission into hospital. Another instance of the highly poisonous nature of mercuric methide had as melancholy a termination, though not a fatal one. About the same time as the preceding case, viz. the beginning of 1865, an assistant in the same laboratory worked for a fortnight with mercuric methide. In two months afterwards he went into hospital with the serious symptoms of having been affected with the vapours of the mercuric methide. This patient soon got quite idiotic, ceased to recognise anyone, became deaf, lost the faculty of speech, and only retained the power of muttering and crying out. He is still living in hospital, with no prospects of recovering, and is a helpless idiot, who can only gather strength to move his limbs convulsively when he becomes violent.

The employment of gas in the chemical laboratory and in the workshop of the manufacturer for heating purposes and as a motive power, has recently been much extended. The very high temperature obtained by the combustion of oxygen and hydrogen in the oxy-hydrogen blowpipe, has drawn attention to gas as a heating agent of the first class. A blowpipe consuming hydrogen with air, has been in use for some years for soldering together the plates of lead forming a sulphuric acid chamber, by merely fusing the edges of the plates, and running the lead of both together. A powerful apparatus for the fusion of small quantities of metals and other substances has been brought out under the name of Gore's furnace; and it is exceedingly useful in chemical laboratories, in dental establishments, and elsewhere, on account of the readiness and despatch with which it raises the temperature of the substance being experimented upon. A gas-engine has been suggested by Lenoir, where coal-gas and air are admitted in proportions to form an explosive mixture, and the alternate explosion of such, by a battery on either side of the piston, propels the piston from one end of the box to the other. The employment of gas-engines for motive power in manufactories would be somewhat expensive, but wherever a small amount of force is required, or where the motive power is desired for uncertain and short periods during the day, the gas-engine will be found highly serviceable. M. Arbos has suggested that the gas required for the engine might be procured more cheaply by passing steam over red-hot charcoal, which would yield carbonic acid, carbonic oxide, and hydrogen; and by transmission over milk of lime, the carbonic acid would be arrested, and the carbonic oxide and hydrogen would be obtained in a mixed state. The cost of such gas is stated not to exceed one-fourth to one-third the price of coal-gas.

Coal-gas of inferior quality may be much improved in illuminating power by passing it through or over naphtha, and experiments made on an extensive scale in the street lamps of London have shown a great increase in illuminating power at a much less cost than that of gas. Mr. Bowditch has been very successful in arranging carburettors for this purpose, and his experiments have proved that a gallon of oil costing 2s., and 1,000 cubic feet of London coal-gas charged 4s. 6d., making together 6s. 6d., will give out more light than 4,000 cubic feet of the gas, which will cost 18s.

Chemical philosophy has advanced with great strides in these later times, and the grouping of substances and their symbolic notation are undergoing great alterations at the present moment. Many of the elementary substances have their combining weights doubled by the new system, and this will necessitate much change in the symbols of the compound substances. The changes which are now taking place had their origin in the observations of Gerhardt, a French chemist, who, desirous of upholding a strict relation between the combining and atomic volumes of substances, announced as a theory or hypothesis, that equal volumes of the elementary gases and vapours, when compared under similar conditions of temperature and pressure, contain the same number of atoms. There is no proof or special test to demonstrate the truth of this theory, but the conclusion was drawn from the desire to reconcile and equalise the combining volume of all elements with their combining weights or atomic weights. The working out of this theory by English chemists has led to a better understanding of the groups of substances, especially those of the kingdom of organic chemistry.

Four distinct groups of elementary substances can be constructed, owing to the proportion of hydrogen with which the elements can unite. Thus, chlorine can combine with hydrogen in the proportion of one volume of chlorine with one volume of hydrogen, forming two volumes of hydro-chloric acid, from which the one volume of chlorine and one volume of hydrogen can again be separated. The chlorine thus unites with one volume or equivalent of hydrogen, and hence the chlorine is regarded as un-equivalent or univalent, and as the chlorine is merely the type of a class, it is stated to belong to the monohydric group of elements. On the other hand, oxygen (with its new combining proportion, 16 instead of 8), always combines with hydrogen in the proportion of one volume of oxygen to two volumes of hydrogen, forming two of steam; and when these two volumes of steam are separated again into oxygen and hydrogen, they are resolved into one volume of oxygen and two volumes of hydrogen. Oxygen, therefore, unites with two proportions of hydrogen; and it is said that oxygen and its class are bi-equivalent or bivalent, and the group is named the dihydric class.

Again, nitrogen unites with hydrogen in the proportion of one volume of nitrogen with three volumes of hydrogen, forming two volumes of gaseous ammonia, from which one volume of nitrogen and three volumes of hydrogen can be separated. The nitrogen, therefore, is tri-equivalent or trivalent, and the class of which nitrogen is the type is the trihydric group. And, lastly, carbon (with its new combining proportion of 12, instead of 6) when it combines with hydrogen, does so in the proportion of one volume of carbon (theoretical vapour) with four volumes of hydrogen, forming two volumes of marsh gas, from which can be separated the one volume of carbon and the four volumes of hydrogen. Carbon and its class always combine with four of hydrogen, and are therefore quadrequivalent or quadrivalent, and the class of substances, of which carbon is the type, is called the tetrahydric group. These classes of bodies may be summed up in the following statement,—one volume of chlorine is satisfied with one volume of hydrogen; one volume of oxygen demands two volumes of hydrogen; one volume of nitrogen calls for three volumes of hydrogen, and one volume of carbon is not content until it receives four volumes of hydrogen.

In the construction of the various organic substances the relative satisfying powers of the chlorine, oxygen, nitrogen, and carbon atoms must be taken into account; and if the carbon does not obtain its four volumes of hydrogen, or its quadruple power of combining be not satisfied, then an imperfect or unstable compound is formed. Several atoms of carbon may be associated together, and, indeed, compounds of the alcohol series are known as high as thirty atoms of carbon, and all these must be satisfied at four points, by being in union with hydrogen or the neighbour atoms of carbon. Where a vacant space or point of the carbon occurs, then it represents an unfinished or unsatisfied molecule.

The law of substitution in organic substances enables the chemist to vary the compounds which are produced. Thus, whilst in marsh gas the one of carbon unites with four of hydrogen, there is no difficulty in taking the compound thus formed and abstracting one, two, three, or even all the four atoms of hydrogen, and putting in one, two, three, or four of chlorine instead; so that there can be formed, compounds of one of carbon with three of hydrogen and one of chlorine, with two of hydrogen and two of chlorine, with one of hydrogen and three of chlorine and, lastly, with four of chlorine alone. In this manner many new substances can be formed; and instead of the chlorine, other elements may be employed in substitution, such as bromine and iodine, forming a new series of substances.

The researches in organic chemistry have led to the actual construction of complex organic compounds from the simplest elements. Till within the last few years, organic compounds were regarded as being the property only of the vegetable or animal kingdom; and it was believed that when the chemist desired to possess any of the members of the group, he must have recourse to the plant or the animal, and crave from it a part of its substance. Now-a-days, however, the organic compounds are manufactured by the chemist without the aid or intervention of the plant or the animal, and every year adds to the number of substances thus produced. Among the organic compounds which have thus been artificially formed are urea, glycerine, grape sugar, alcohol, and prussic acid.

The advances which have been made in organic chemistry in modern times teach us, that by merely following the beaten track of observation, by simply travelling the roads already laid down, there are apparently many millions of substances waiting to be formed and named. Indeed, it has been calculated that there are several sextillions of organic bodies which may yet be discovered by carrying out the present modes of research.

The progress of the science of chemistry, where the elements are combined together to form compounds, may be likened to the union of letters to form words; but the process does not stop there, but may be still further considered to be the throwing of these words into sentences, forming an endless chain of ideas—an endless chain of new chemical compounds. It should, therefore, be observed that the various substances which form types of the classes of bodies are representative of hundreds of substances which are already known, and doubtless millions of bodies to be yet formed. And remember that twenty years ago this country was undiscovered; the roads or modes of operating were few; but each year must add to the number of new substances as the great domain of organic chemistry is explored.

And how much may we expect to reap as the reward of human labour in chemical science? Natural substances, as found in the mineral, vegetable, or animal kingdoms, are few as compared with the compounds which are artificially formed, and yet not artificially. The ingenuity of man is exerted on natural substances by natural laws, and he as the artificer merely places stone upon stone, and chemical affinity or attraction binds them together.

How many more substances of vast commercial interest, such as the aniline colours, may be compounded by man, it would be hard to tell; and how many more of medical interest, such as chloroform, it would be presumptuous to speculate upon. As far as the locomotive or iron horse surpasses all the energies of the animal as an aid in locomotion, and gunpowder in the rifle eclipses the human arm in the range and power of its aim, so, doubtless, the researches and applications of chemistry will continue to transform natural substances into new compounds of vast interest to humanity.

REVIEWS AND NOTICES OF NEW BOOKS.

Conservation des plaques des navires cuirassés et des coques en fer par l'application directe d'un doublage en cuivre. Par F. L. Roux, Capitaine de frégate. (Preservation of iron clads and hulls by means of copper sheathing.) Paris, A. Bertrand, 1866.

With a view to prevent the action of the electric fluid tending to loosen the armour plates of iron clad vessels, and thus render them inefficient or unseaworthy, Capt. Roux proposes that a direct copper sheathing be applied to them. By this means three paramount advantages are, in his opinion, to be arrived at, viz.:—

1st. An almost unlimited preservation of armour plates and iron hulls.

2nd. Increase in the speed of headway, and consequent saving of fuel.

3rd. Perfect safety in undertaking long voyages. The vessels may be stationed or remain in active duty in all seas, without the necessity of an occasional docking.

The little work under notice gives a complete *exposé* of the system recommended by the author. Prefixed to it is an excellent wood engraving representing the iron clad turret corvette *La Belliqueuse*, copper sheathed at Toulon, in 1866, under Capt. Roux's directions; and at the end we find a lithograph, remarkably well executed, of the iron clad barge on which the first experiments were made by the author. Although the novelty of the process under notice is by no means established, and its advantages still remains to be demonstrated, Capt. Roux's memoir is highly interesting and will fully repay a careful perusal.

Die Ursachen der Dampfkefselexplosionen. Von EMIL BLUM, Civil Ingenieur nnd Assistent der K. Preuss, Gewerbeakademie, Berlin. (The Causes of Steam Boiler Explosions. By E. Blum, C.E., &c.) Chemnitz, E. Focke. 1866.

For some years past, much has been done in various quarters towards elucidating the causes and devising proper means for the prevention of steam boiler explosions, which have become a scourge in this country and the United States, and are not wholly wanting in Continental Europe, notwithstanding an extensive Government snrveillance. Although the subject has of late years been much discussed in engineering works and periodicals, an exhaustive monograph on the same still remains a desideratum. Herr Blum's pamphlet contains an inquiry into the *causes*, the knowledge of which, in his opinion, carries with it the requisite *cure* of the evil. Now these causes are, in a somewhat arbitrary manner, divided into four classes. Explosions are stated to arise

1st. From the chemical action of the *fuel.*

2nd. The decomposing and otherwise injurious action of the *water*.

3rd. The external action of *heat*, and

4th. The internal action of the pressure of *steam.*

This classification is open to criticism, especially the distinction of causes 3 and 4, which, being indissolubly connected with each other, might as well be merged into one. However, each of the four heads is thoroughly and ably discussed. Empirical means of prevention are altogether repudiated, and several of the usnal conjectures dismissed as untenable. Among the latter we find the so-called Leidenfrost phenomenon, consisting in the rotation and slow evaporation of water-drops poured on red-hot iron. Many examples, some of them rather irrelevant, are adduced as evidence, and the frequent quotations aud somewhat scholastic tone show that the author is a well-meaning *débutant* as a writer on engineering subjects. His observations on the inefficiency of Government inspection we cannot entirely endorse, yet we fully concur in his opinion that careful and skilled firemen will require no printed rules and regulations and very little external pressure to make them keep their steam generators in good working order. On the whole, Herr Blum's pamphlet is an able contribution to the literature of the subject, and we recommend its perusal to all those of our readers acquainted with the German tongue.

The Gardener: a Monthly Magazine of Horticulture and Floriculture. Edited by William Thomson, Dalkeith Gardens. January, 1867. London: W. Blackwood and Sons.

HORTICULTURE and floriculture can hardly be termed industrial arts, and cannot well be reckoned among the subjects forming the scope and province of THE ARTIZAN. However, as many of our readers, doubtless, indulge in the useful and recreative art of gardening, we may as well bring the appearance of our botanical contemporary under their notice. According to its introductory address, its object will be—

> To become useful to that large and increasing class of the community who, previous to the development of our railway system, lived in cities, but who now live in the country, and occupy their hours of relaxation from city business in managing, with or without the aid a common labourer, their suburban gardens.

The number before us contains forty octavo pages of horticultural matter, one-fourth of which is devoted to the flower garden. All those in any way interested in the subject will find *The Gardener* a useful and pleasant guide and companion.

BOOKS RECEIVED.

A Treatise on the Screw Propeller, Screw Vessels, and Screw Engines. By JOHN BOURNE, C.E. New edition. London: Longmans, Green, Reader, and Dyer. Part XV., December, 1866, and Part XVI., January, 1867.

CONTAIN the continuation of "Scientific Principles involved in the operation of screw vessels" and the following plates:—Views of the French screw steam frigate *Pomone*, and engines of the screw steamships, *City of Glasgow*, *City of Manchester*, and *Glasgow*, in Part XV.; and details of United States war steamer, *Princeton*, and engines of screw steamship *Correo*, in Part XVI.

NOTICES TO CORRESPONDENTS.

N. F.—The substitution of the linear proportions between abscissæ and ordinates for trigonometrical functions is applicable only to minor purposes, such as the measuring of heights and sometimes of distances. For extensive surveys it would not answer.

VAPOR.—The table to be found in Nystrom's pocket-book (to be obtained at Spon's), will suffice for your object.

RUOTA.—A turbine will do far better in your case than an overshot wheel. You must ascertain yourself whether your water supply is sufficiently copious and regular to warrant its utilisation for hydraulic motion.

S. L.—You will find the information sought for in Rankine's work on "Civil Engineering." (Published by Griffin and Co.)

T. N. (Glasgow).—You may inspect Mr. Scott Russel's great work on shipbuilding, published in three large folio volumes, by Messrs. Day and Sons, at the Chambers of the Institution of Engineers in Scotland.

Q. (Edinburgh).—Apply to our agents in Glasgow, Messrs. W. R. M. Thomson and Co., 20, Buchanan-street.

R. C. M. (New York).—You had better call on Mr. Charles Haswell, 6, Bowling-green, in your city. He will no doubt supply you with the information you require.

NYSTROM.—We shall be glad to hear from you.

PRICES CURRENT OF THE LONDON METAL MARKET.

	Dec. 29.	Jan. 5.	Jan. 12.	Jan. 19.
COPPER.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Best, selected, per ton	89 0 0	89 0 0	89 0 0	89 0 0
Tough cake, do.	86 0 0	86 0 0	86 0 0	86 0 0
Copper wire, per lb.	0 1 0½	0 1 0½	0 1 0½	0 1 0½
„ tubes, do.	0 1 0	0 1 0	0 1 0	0 1 0
Sheathing, per ton	91 0 0	91 0 0	91 0 0	91 0 0
Bottoms, do.	96 0 0	96 0 0	96 0 0	96 0 0
IRON.				
Bars, Welsh, in London, per ton	7 0 0	6 10 0	6 15 0	6 7 6
Nail rods, do.	7 10 0	7 0 0	7 0 0	7 0 0
„ Stafford in London, do.	8 7 6	7 7 6	7 15 6	7 15 6
Bars, do.	8 5 0	7 5 0	7 15 0	7 15 0
Hoops, do.	9 5 0	8 5 0	8 15 0	8 15 0
Sheets, single, do.	10 0 0	9 0 0	9 10 0	9 10 0
Pig, No. 1, in Wales, do.	4 5 0	4 5 0	4 5 0	4 5 0
„ in Clyde, do.	2 15 0	2 15 6	2 15 3	2 15 0
LEAD.				
English pig, ord. soft, per ton	20 5 0	20 5 0	20 5 0	20 5 0
„ sheet, do.	21 0 0	21 0 0	21 0 0	21 0 0
„ red lead, do.	21 10 0	21 10 0	21 10 0	21 10 0
„ white, do.	27 0 0	27 0 0	27 0 0	27 0 0
Spanish, do.	19 10 0	19 10 0	19 10 0	19 10 0
BRASS.				
Sheets, per lb.	0 0 10	0 0 10	0 0 10	0 0 10
Wire, do.	0 0 9	0 0 9	0 0 9	0 0 9
Tubes, do.	0 0 11	0 0 11	0 0 11	0 0 11
FOREIGN STEEL.				
Swedish, in kegs (rolled)	14 0 0	14 0 0	14 0 0	14 0 0
„ (hammered)	16 0 0	16 0 0	16 0 0	16 0 0
English, Spring	19 0 0	19 0 0	19 0 0	19 0 0
Quicksilver, per bottle	6 18 0	6 18 0	6 17 0	6 17 0
TIN PLATES.				
IC Charcoal, 1st qu., per box	1 14 0	1 14 0	1 14 0	1 12 0
IX „ „ „	2 0 0	2 0 0	2 0 0	1 18 0
IC „ 2nd qua., „	1 10 0	1 10 0	1 10 0	1 8 0
IC Coke, per box	1 4 6	1 4 6	1 4 6	1 4 6
IX „ „	1 10 6	1 10 6	1 10 6	1 10 6

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

NUISANCE ARISING FROM SEWAGE.—PHILIPPS *v.* CROUCH.—The plaintiff sold to the defendant, a builder, land in the parish of Wimbledon, for building purposes, and at a building price of £600 an acre. The defendant erected ten houses, and afterwards laid down pipes, in order to drain the sewage into a ditch on the plaintiff's land, and which drained the surface water off that land. The defence was that this sewage did not create a nuisance, that the sewage from other houses was drained into the ditch, and that the defendant had a right, under the law of necessity, to drain into the ditch. Vice-Chancellor Stuart held that if the defendant had been a man of foresight he might have taken into consideration the question of how his houses were to be drained, and have obtained the grant of an easement from the plaintiff; but he had not done so, and the

Court could not infer that he had an easement. The nuisance having heen proved, there would be a decree for an injunction, with the costs of the suit, to be paid by the defendant.

Raphael v. the Thames Valley Railway Company.—Agreements to be Literally adhered to.—The company contracted by an agreement with the plaintiff, that, in constructing their railway through his estate, they would make the line on a certain level, and construct a road and bridge for the plaintiff's use at the places specified in a certain plan. The company finding, as they alleged, that it would be impossible to adhere to the agreement, commenced making their line on a higher level, and to erect the bridge in a different place to that indicated it the plan. This breach of agreement the plaintiff complained of, and also that the road was not as contracted for, and he filed a bill for an injunction to restrain the company. Upon the hearing of the cause the Master of the Rolls held that, although there had been a breach of the agreement, this Court ought not to interfere by injunction, and dismissed the bill, but without prejudice to any right the plaintiff might have for damages at law. Upon the plaintiff's appeal the Lord Chancellor decided that there had plainly been a breach of agreement by the company; that the plaintiff was entitled to a specific performance of the agreement, and therefore a decree must be made to that effect, and the decision of the Court below reversed.

The Rights of Assignees.—Daw v. Eley.—This was a motion to commit the defendants, Messrs. Eley Brothers, cartridge makers, of Gray's Inn-lane, for breach of the injunction obtained by the plaintiff in November, 1865, by which they were restrained from manufacturing or selling cartridges for breech-loaders in infringement of Schneider's patent for improvements in central fire breech-loading cartridges, now vested by assignment in the plaintiff, Mr. Daw, gunmaker, of Threadneedle-street. This case presented a very complicated aspect, and its trial in Vice-Chancellor Wood's Court occupied three days. From the copious evidence adduced, the following leading facts may be gathered. The cartridges in question were patented by Messrs. F. E. and G. Schneider, in France, in 1858, and subsequently in England, in 1861, and the British patent rights assigned to the plaintiff. The validity of the French patent was subsequently tried before the Civil Tribunal of the Seine Department, Paris, and on February 22, 1866, the pateutees were declared "legally deprived of all rights and advantages" accruing to them from their patents, owing to non-payment of the annual tax of 100 francs. The two questions at issue were:—1st. Whether the annulment of the patentees' rights in France affected the assignees' rights in Great Britain. 2nd. Whether Schneider's French patent of 1858 was identical with his British patent of 1861. The second question having, by the evidence adduced, been fully answered in the affirmative, Vice-Chaucellor Wood held that by Sect. 25 of the Patent Law Amendment Act, the British patent became virtually void simultaneously with the determination of the corresponding foreign patent. The plaintiff's title could, therefore, not be sustained, and his application had to be dismissed, with costs.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Iudustrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Shipping Trade of the United Kingdom.—From a return lately issued we extract the following particulars respecting the tonnage of all the ships registered as belonging to the United Kingdom at the end of 1865. It appears that of the gross tonnage

England and Wales owned		4,653,811	tons.
Scotland	„	766,975	„
Ireland	„	246,087	„
Isle of Man	„	12,455	„
Channel Islands	„	80,981	„
Total		5,760,309	„
Of which the tonnage of steamships amounted to		823,533	„
„ „ sailing ships	„	4,936,776	„
At the time named London owned:—			
Sailing ships ... 2,563	with	855,575	„
Steamers ... 724	„	302,909	„
Total 3,287 ships	„	1,158,484	„
Liverpool owned:—			
Sailing ships ... 2,641	„	1,381,651	„
Steamers ... 398	„	186,313	„
Total 3,039 ships	„	1,567,964	..

The joint tonnage owned by London and Liverpool amounts to 2,726,448 tons, or nearly one-half of the aggregate tonnage of the United Kingdom. One of the most striking facts to be gathered from this statement is the smallness of the tonnage owned by Ireland, its shipping trade being not quite one-third of that of Scotland, whilst the extent of its coasts is far larger thau that of North Britain, and its population still more than double that of the latter.

The Prussian Navy consists at present of 1 ironclad turret ship, 1 ironclad ram, 4 frigates, 4 corvettes, 23 gunboats, and 3 dispatch boats, all of them screw steamers, with a total of 263 guns; and 3 frigates, 1 corvette, 3 brigs, and 40 gun sloops, all sailing vessels, carrying a total of 285 guns. Tho tonnage of the mercantile navy of North Germany at the end of 1863 was 1,261,000 tons, while at the same epoch the commercial fleet of Great Britain counted 5,308,000, that of France 1,044,000 tons.

Mineral Traffic on British Railways.—The following is a comparative view of the quantities of coals and other minerals carried on the twelve principal railway systems of Great Britain, during 1864 and 1865, and a statement of the receipts derived from such traffic during 1865.

System.	Mineral Traffic in 1864. tons.	Mineral Traffic in 1865. tons.	Receipts from Mineral Traffic during 1865. £.
Caledonian	5,125,757	5,226,275	429,097
Great Eastern	776,818	885,400	134,878
Great Northern	1,934,662	2,254,218	429,811
Great Western	4,574,829	4,832,415	501,537
Lancashire and Yorkshire	3,507,889	3,888,487	189,186
London and North-Western	8,095,164	9,039,650	891,818
London and South-Western	440,500	481,282	44,390
London, Brighton, and South Coast	399,840	511,194	48,584
Manchester, Sheffield, and Lincolnshire	1,769,414	2,146,514	164,596
Midland	5,357,004	5,352,299	593,841
North-Eastern	15,3[illegible],276	15,309,991	1,300,809
South-Eastern	198,132	208,361	31,865

Indian Ink.—The preparation of Indian ink, as well as compositions used by the Chinese iu painting, is not based on any reliable anthority, being shronded in a considerable quantity of "trade haze and secret bog." The composition appears by experiment to be the coal of fish-bones, or some vegetable substance mixed with isinglass size, or other size in conjunction with honey or sugar, to prevent its cracking. A good Indian ink may be made from the fine soot from the flame of a lamp or candle, received and collected by holding a plate over it. Mix this with the size of parchment, and it will be found to be a good deep colour. Burnt rice has been considered by some a principal ingredient in the genuine Indian ink, with the addition of perfumes or other substances not essential to its qualities as an ink.

A Diatom.—A diatom is characterised by having a flinty case or shell, beautifully marked with lines, or rows of dots; but these are often so fine and close together that they cannot be distinguished, except with a well-constructed instrnment and high powers (a ¼-in. objective will do for most), and this has led to the employment of some of these as test-objects—that is to say, that if one glass will define the markings better than another, it is considered more fit for scientific purposes; and so great is the difference between the size and the distance apart of the markings, that some may be used as tests for the low powers, while others can only be used for the highest. Many of these beautiful forms can be found living in the Thames, and other rivers on our own coasts. In the months of April, May, September, October, aod November they will be found in the greatest abundance and variety; the salt marshes on the banks of most of the rivers will also repay the trouble of searching for them.—*Hardwicke's Science Gossip.*

Village Natural History Societies.—In most places there is at least one person who takes an interest in Nature's works. Very probably he is in humble circnmstances; in all likelihood he is considered harmlessly insane by his compeers, or, as they would phrase it, "a button short!" There are also usually two or three more, who use their eyes, and know something of the habits of birds, insects, or plants. If these three or four would meet together, and talk the matter over, they could arrange affairs according to their own convenience; and, all being straightforward, we may suppose them to agree in inviting as many people as they think likely to come, to attend at such a place on such a night. In villages it is always easy to hire a room for such a purpose at a trifling cost; and in them, as in towns, one or more of the parties interested will, in all probability, be able to lend a room or rooms, on one occasion at least. Where practicable, the sociability of the evening is much enhanced, by having tea or coffee handed round before the real proceedings begin. The conversation which then arises serves to place at their ease those who might otherwise be prevented by shyness from taking part in the business of the evening. Indeed our experience leads us to believe that natnralists seldom find any difficulty in conversing with one another when once the ice is broken; and the pursuit of Nature is so truly Catholic that Churchman and Dissenter, Papist and Protestant, can alike join in it without fear of treading upon one another's (mental) corns. The humanising influence of Natural History is certainly not the least of its many charms; and it is pleasant to notice how the instinctive good feeling, which all true naturalists possess, enables them to avoid topics which are likely to be in any way distasteful to those with whom they are temporarily associated."—*Hardwicke's Science Gossip.*

State of the Metropolitan Thames Embankments.—From chief engineer Bazalgette's report to the Metropolitan Board of Works we find that the following was the stage the progress of these works had reached at the end of 1866. *Northern Embankment:*—Contract No. 1 (between Westminster and Waterloo Bridges).—About 3730ft. in length of iron caissons and timber coffer dams have been constructed or are in various stages of progress; 2,637ft. of the low level sewer, 2,123ft. of the subway, 2,925ft. of the 4ft. by 2ft. 8in. sewer, hitherto discharging on the foreshore of the river, and 284ft. of the flushing sewer have been completed. About 3¾ft. above Trinity high-water mark of the Westminster steam-boat pier, for a length of 320ft., have been completed; 45ft. in length of the Charing-cross steam-boat pier and 306ft. of the river wall have been brought to heights varying from 1ft. to 4¼ft. below Trinity mark. The Adelphi landing stairs are progressing favourably. Filling to the extent of from 400,000 to 500,00 cubic yards had been carried out behind the walls and works of the embankment. £8,269 worth of work had been done during December. Between Waterloo Bridge and Temple gardens (contract No. 2), about 60ft. of the river wall, sewer, and subway, is completed within 4ft. of Trinity high-water mark. Beyond this the only remaining portions of the work to be executed to complete the contract are the parapet and the upper part of the Temple steam-bost pier, the stone for which is arriving on the ground. The approximate value of the work done, and of the materials and plant upon the ground, is £206,616, of which the sum of £2,058 is due to the progress made during December. Of the total amount the proportionate sum of £195,319 is for works, £8,297 for materials, and £3,000 for plant. But little progress has been made during the past month with the Isle of Dogs branch of the low-level sewer in consequence of the contemplated alterations in the line of sewer near the East and West India Dock entrances. The value of the work completed is £59,558, of which sum £3,213 represents the progress of the past month. Fair progress has been made at the Abbey Mills pumping station. The value of the work completed is £93,230, £5,230 being for the progress during the last month. *Southern Embankment:*—A length of 2,370ft. of the dam and staging has been driven to a depth averaging 15½ft. Within the dam, about 1,600ft. in length of the river wall have been brought up to levels varying from 17ft. 4in. to 6in. below Trinity high-water mark, and about 300ft. of the wall have been brought to a level of 3ft. 9in. above that mark. There have been 520 rods of brickwork laid, 60,000 cubic feet of stone bedded, and 236,000 cubic feet of timber, 13,000 cubic yards of clay puddle, and 185 tons of iron used.

The Main Drainage of the Metropolis.—According to the annual report of the Metropolitan Board of Works, the whole of the main drainage sewers, with the exception of the Northern Low Level, have been completed, and are now in active operation. The works were commenced in January, 1859, and the ceremony of their formal opening took place on the 4th of April, 1865. The total length of sewers forming the system is 82 miles, and, in conjunction with the pumping stations and other works, when completed

will have cost about £4,200,000. The extent of area the drainage of which is intercepted and carried off by these sewers, is about 117 square miles, having a population of 2,809,000. On the north side of the river the sewage, intercepted daily, at present amounts to 10,000,000, and on the south side to 4,000,000 cubic feet. In designing the sewers provision has also been made for taking the drainage arising from the present and prospective water supply of the same area, and the increased quantity of sewage. In the construction of the other sewers and works 318,000,000 bricks and 880,000 cubic yards of concrete, have been used, and about 3,500,000 cubic yards of earth excavated. These extensive works, embracing almost every branch of engineering science, have been constructed under buildings and over and under rivers, canals, railways, and roadways, from 25ft. above, to 75ft. below the surface, without any important casualty or interference with the public convenience or traffic.

THE difference of LONGITUDE between HEART'S CONTENT station, Newfoundland, and that at VALENTIA, or, in other words, between the extreme points of the Atlantic cable, has been ascertained by Mr. Gould, coast surveyor to the U.S. Government, to be 2° 56′ 56·5″.

ROYAL NAVY.—VESSELS ON THE RETIRED LIST.—The following vessels have been broken up or sold out of the Royal Navy, and their names removed from the official list during 1866, viz ;—the *North Star*, 22, 1,857 tons, 400 horse-power; the *Menai*, 21, 1,857 tons, 400 horse-power; the *Orestes*, 21, 1,715 tons, 400 horse-power, screw corvettes; the *Isis*, 2, 1,331 tons, sailing frigate; the *Tartar*, 20, 1,296 tons, 250 horse-power, screw corvette; the *Tribune*, 23, 1,570 tons, 300 horse-power, screw frigate; the *Vulture*, 6, 1,191 tons, 470 horse-power, paddle-wheel frigate; the *Devastation*, 6, 1,058 tons, 400 horse-power; the *Styx*, 6, 1,057 tons, 280 horse-power, and the *Stromboli*, 6, 1,054 tons, 280 horse-power, paddle-wheel sloops; the *Desperate*, 8, 1,038 tons, 400 horse-power, screw sloop; the *Archer*, 13, 973 tons, 202 horse-power, and the *Encounter*, 14, 953 tons, 360 horse-power, screw corvettes; the *Wye*, 700 tons, 100 horse-power, iron screw steamer; the *Foxhound*, 4, 681 tons, 200 horse-power, screw gun vessel; the *Harrier*, 17, 748 tons, 100 horse-power, screw sloop; the *Wanderer*, 4, 675 tons, 200 horse-power, screw gun vessel; the *Weser*, 6, 590 tons, 160 horse-power, iron paddle-wheel steamer; the *Firefly*, 5, 550 tons, 220 horse-power, paddle-wheel steamer; the *Swallow*, 9, 486 tons, 60 horse-power, screw sloop; the *Coromandel*, 5, 303 tons, 150 horse-power, and the *Prospero*, 244 tons, 144 horse-power, paddle-wheel steamers; and the *Dover*, 224 tons, 90 horse-power, iron paddle-wheel steamer.

NAVAL ENGINEERING.

TRIAL OF THE "WATERWITCH."—This vessel, a sister ship of the *Nautilus*, which we noticed last summer, is propelled on Ruthven's plan by a column of water forced out of each side of the vessel by a turbine. After various previous experiments attended with a doubtful result, the *Waterwitch* made a successful trial trip on January 1st. She left Sheerness about half-past nine o'clock under the charge of Staff Commander Dillon, R.N., and after gently steaming down the river, made her first run at the measured mile on the Maplin Sands about half-past eleven. Her trim was very good, and she floated on a nearly even keel, her draft of water being 9ft. 5in. forward, and 9ft. 8½in. aft, her mean light draft being thus 9ft. 6¾in., her intended load-draft line 10ft. 6in. The following were the results of the runs made:—With the tide, 11·067, 10·651, and 10·375 knots; against the tide, 9·091, 9·207, and 9·651 knots; the average mean result being 10·007 knots, or 11⅝ miles per hour—a rate of speed that compares most favourably with the rates accomplished by her sister ships the *Vixen* and *Viper*, the former fitted with twin screws, doing 9·012 knots, with a draft of 9ft. 10in. forward, and 10ft. 10in. aft.; and the latter, also with double screws, with a draft of 9ft. 6in. forward, and 10in. 10in. aft, doing 8·952 knots per hour. All these gun-boats have engines of 150 nominal horse-power, but have been worked up to over 700 indicated horse-power. During the whole of the trial the *Waterwitch* maintained a very uniform speed, her rate on the ordinary journey being nearly as great as that got up over the measured mile. On the voyage the engine pretty generally made 40 revolutions a minute: during the runs the number of revolutions were 42, 42, and 42½. Thus it appears that the *Waterwitch* has done a higher speed than either of the other vessels she is matched against; whilst neither the screw, double screw, or paddle, can work under the same conditions as the turbine and its water-nozzles, as regards safety and reliability in time of naval warfare. A further trial which took place on January 11th, proved equally successful.

SHIPBUILDING.

AN IRON SCREW PASSENGER STEAMER, brig-rigged, was launched from Messrs. Denton, Gray, and Co.'s yard at Hartlepool, on January 7th. Her dimensions are as follows:—Length 207ft., extreme breadth 30ft., depth of hold 17ft. 4in., being of the gross tonnage N.M. of about 709. The rigging is of galvanised wire, and she is fitted to accommodate twenty passengers. Her engines, of inverted direct action, are equal to a nominal horse-power of 130, and were built by Messrs. Richardson and Son. The boilers are tubular. The tonnage, builder's measurement, is estimated at 1,711. Her entire length 280ft., breadth 36ft., and depth 29ft.

RAILWAYS.

THE AERIAL RAILWAY OF NEW YORK.—This railway which is proposed for the purposes of intramural traffic, is to be supported upon wrought iron columns, one foot in diameter and fourteen feet high, secured in blocks of iron. Streets are to be spanned with ornamental bridges. The motive force is to be supplied by engines of thirty horse-power, placed in vaults beneath the streets at intervals of half a mile. These are to work an endless chain of wire rope revolving over large drums, extending about a quarter of a mile each way from the engines, and returning by an iron tube placed beneath the pavement. The carriages are to be of a peculiar construction, capable of being stopped at any moment by the conductor, with the application of a lever. The stations are placed at equal distances from each other, and waiting-rooms are to be on a second floor of buildings adjoining. The railway passengers ascend and descend by staircases. It is said that the Mayor of New York has some doubts as to the legality and powers of the company, and has not sanctioned the works.—A similar plan was proposed for London upwards of twenty years ago.

DOCKS, HARBOURS, BRIDGES.

THE BATTERSEA AND PIMLICO RAILWAY BRIDGE.—On January 1st, this bridge, having been considerably widened from the foundation upwards, and which is stated to be the widest bridge in the world, was opened for public traffic simultaneously with the new line of the Metropolitan Extension of the London, Chatham, and Dover Railway Company, from Brixton to the Victoria Station. According to the plans of Sir Charles Fox, the new structure has four river spans of 175ft. each, and two land openings at each end of 70ft. The river openings are segmental in shape, and the ribs of wrought-iron have a rise of 17ft. The three piers in the river have each at the level of springing of ribs a thickness of 12½ft. and the two abutments are 20ft. thick each at that level, so that the total length of the whole bridge is about 310 yards. The width of the bridge at rails level is 110ft., wide enough for eight lines of rails, and this width is carried by seven main ribs to each span. The abutments have been carried down to a depth of over 18ft. below low water mark, with the brickwork in cement, and the excavations for the abutments, owing to the great width of the bridge and form of ribs had to be 125ft. long and 48ft. wide. The piers are supported by brickwork in cylinders, the latter, four in number, being sunk to a depth of 45½ft. below high-water mark. Each is 21ft. in diameter, and made of cast-iron in lengths of 8ft., each length composed of eight segments. The length of each pier at the level of the cylinders is 130ft. The weight of iron in superstructure and cylinders, &c., is estimated at about 3,000 tons. 100,000 cubic feet of stone has been used, 10,000 cubic feet of brickwork, and about 300,000 cubic feet of timber. Each of the cylinders has been weighted with a load of 1,000 tons to test the foundations, and at low water mark cast-iron girders are fixed between them and the existing pier. The parapet on the east side of the old bridge has been removed and placed on the new one. The new bridge is about 52ft. wide than Westminster Bridge.

FOUNDATION OF BLACKFRIARS BRIDGE.—The Scottish Granite Company, Pollockshields, near Glasgow, are at present employed in the preparation of eight polished granite columns for the piers of Blackfriars Bridge, now being rebuilt by the Corporation of the City of London. The first of these monoliths is in an advanced stage of progress and forms the largest block of granite ever wrought into a polished column in Scotland. It is 7ft. in diameter and 11ft. in length. Four of the blocks are to be 8ft. in diameter and 12ft. in length. The material is red syenitic granite of Mull, which takes the finest possible polish.

MINES, METALLURGY, &c.

IRON IN AMERICA.—The iron product of the United States is gradually increasing. Pennsylvania is the leading producer, but the business is making fair progress in other sections, particularly in the Lake Superior region. The product of the Marquette Iron Mines for 1863 was 185,000 gross tons of ore, 13,000 gross tons of pig-iron, against only 1,447 tons eight years previously. Previous to the 1836 there was not an iron blast-furnace in the United States using anthracite coal, while at present two-thirds of the iron blast-furnaces in the State of Pennsylvania are using anthracite coal to make iron.

BOILER EXPLOSIONS.

AT PENDLETON, on December 15th last, a steam boiler explosion took place at the bar iron works of Messrs. Maybury, Matthews, and Co., Brindle Heath. The exploded boiler is one of four in connection with the engine for driving the rolls, and had only been in use for about six months. The brickwork on each side of the boiler was thrown down, and the boiler itself was carried about a foot forward in its bed, thus breaking the connection of the steam pipes, so that the steam was blown off from the other boilers, and the works at once stopped. The bricks were thrown in a shower about the place. The roof over the puddling furnaces, immediately behind the boilers, was carried away by the force of the explosion. A lad had his leg broken by a brick, and had a narrow escape from death. A man named William Matthew was struck on the head by a brick, by which he was severely injured, as well as scalded by the hot water. The injuries sustained by others were less severe, although a hundred men were at work at the time of the accident. The total damage to the works, was about £100.

APPLIED CHEMISTRY.

HARDENING PLASTER OF PARIS.—Knmman, who has given much time to the study of the coloration of minerals, and their power of absorbing various organic substances, states that, if plaster of Paris, with enough water in it to give it the constitution CaO, $SO_2 + 2$ HO, is steeped in a bath of hot pitch, it loses its two equivalents of water, which are replaced by a corresponding quantity of pitch, and that it then becomes very hard and susceptible of a polish, so that it would be available for the construction of many articles for ornament or use.—*Journ. Franklin Institute.*

CHEMICAL NATURE OF CAST-IRON.—At the late meeting of the British Association, Dr. Russell read a preliminary report, prepared by Dr. Matthieson, F.R.S., "On the Chemical Nature of Cast-Iron." Facts were quoted to show that the crystallised alloys of carbon and iron do not prove the existence of chemical combination between them. In all probability, by altering the conditions of cooling, &c., crystals of iron containing various amounts of carbon might be obtained from the same sample of cast-iron. Data were given to show that the alloys of iron follow in some cases the same laws as other metals; and in order to see whether the assumption as to the chemical nature of cast-iron was correct it was proposed—1. To make some pure iron. 2. To alloy the pure iron with various amounts of carbon, and to test the physical and chemical properties of these alloys. 3. To alloy the pure iron in different proportions with other metals and metalloids. From the foregoing considerations the author expected to be able to produce analogous alloys to iron and carbon, with some other metals having the peculiar properties of cast-iron, steel, and wrought-iron, and probably some may be found to be much better adapted for certain purposes than the alloys of carbon and iron; for instance, less liable to be crystallized by age, &c. 4. To alloy the pure iron with various amounts of carbon, and to add to these alloys such substances as are found in the commercial iron, so as to study their respective effects on the physical and chemical nature of cast-iron, and more especially on their influence on the solvent power of iron for carbon. It is intended to investigate carefully the action of dilute and strong acids on the various alloys of iron and carbon, in order to see how far and under what conditions the carbon is evolved as carburetted hydrogen. The experiments will be made upon a small scale, fusion taking place in one of Deville's oxyhydrogen furnaces, which gives an admirable means of experimenting with refractory metals. The pure iron will be partly prepared from the oxalate, and partly by the electrotype process, and fused in lime crucibles. The experiments had already been commenced, and the author hoped at the next meeting of the Association to report good progress. Prof. Playfair said that as the members intended an excursion to Riddings Colliery and the Alfreton Ironworks, he might mention that one of the objects of interest was a peculiar furnace, celebrated for its antiquity, being 40 or 50 years old, whereas the average duration of iron furnaces was only of about four or five years. Recently a part of the wall was taken down for repairs, and he then had an opportunity of examining the whole of the furnace, and of ascertaining how it was that it had lasted so long. To his surprise, he found it lined with plumbago 3 or 4in. thick, not by the manufacturer, but by the operations of nature. This result he attributed to the carbon in the iron having been squeezed out; and the whole of the furnace was, probably, lined with plumbago. He though they might congratulate themselves upon the promise of Dr. Matthieson, that he would continue his researches.

CHROMATE OF COPPER.—Under this name a green liquid is sold, consisting of a solution of neutral chromate of copper in ammonia. It is much used for dyeing, and is, according to Stinde, prepared by the following method:—Dissolve bichromate of potash, 1p., in hot water, 20p.; and add sulphate of copper, 2p., keeping the temperature near the boiling point, and supplying the place of the evaporated water by fresh hot water. When all is dissolved, add gradually a solution prepared with crystallised carbonate of soda, 1p.; boiling water, 2p.; re-dissolve the first-formed precipitate by shaking, and at the same time carbonic acid will be disengaged; when no more of the latter is evolved, stop the shaking; a brown precipitate will have been formed, consisting of chromate of copper, which allow to deposit, and decant. Wash the precipitate three times in warm water so as to remove the sulphate of potash, then with cold water; afterwards dry and add ammonia of 0·91 density. Any excess of ammonia must be avoided, and it should be added in small quantities at a time, as the precipitate is very soluble. Filter quickly through flannel, reduce by evaporation to 25° B., and preserve in closed vessels.—*Chemical News.*

WATERPROOFING.—The following plan of rendering tissues waterproof is said to be very effective:—Plunge the fabric into a solution containing 20 per cent. of soap, and afterwards into another solution containing the same percentage of sulphate of copper; wash the fabric, and the operation is finished. An indissoluble stearate, margarate or oleate of copper, is formed in the interstices of the tissue, which thus becomes impervious to moisture. This process is particularly recommended for awnings, and similar objects.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated December 4th, 1866.

3189 W. H. Richardson—Manufacture of iron and means for effecting the same
3190 E. L. Paraire—Looms for weaving
3191 W. E. Hickling—Machinery for the prevention of collisions and other accidents on railways
3192 W. A. Marshall—Insulating and protecting electric telegraph wires, and apparatus employed therein

Dated December 5th, 1866.

3193 T. Bayley and J. Taylor—Hats or coverings for the head
3194 J. M. Worrall—Finishing certain descriptions of piled fabrics, and apparatus connected therewith
3195 C. E. Brooman—Colouring matters
3196 R. Harrild and H. Harrild—Printing machines
3197 T. Bridges and J. Bigwood—Furnaces of steam boilers
3198 C. M. Fontenoy and J. M. Dopfeld—Fastenings of covers for powder flasks or cases used in naval gunnery
3199 V. Vandroy—Cast iron sash windows to be adapted to p rline tile or slate roofing
3200 J. Toward—Brick machinery
3201 H. F. Swears—Means of communication between stations and railway trains in motion, &c.
3202 J. Firth and E. Firth—Railway crossings
3203 T. J. Chubb—Manufacture of steel or metal having some of the propert es of steel
3204 F. Palmer—Projectiles
3205 T. J. Chubb—Separating substances of different specific gravities
3206 J. Barwick and S. Tindall—Packing for the piston rods of steam engines, &c.
3207 W. Clark—Rotary engines
3208 R. Carte—Improvements in the flute

Dated December 6th, 1866.

3209 H. Wilde—Electro-magnetic and magneto-electric machines
3210 R. Duncan—Applying auxiliary power to sailing ships
3211 L. Cobe—Pressing, smoothing, or ironing the surfaces of fabrics
3212 P. E. de Wissocq and L. Krasinski—Treatment of ores of metals
3213 W. Selby—Lace made in twist lace machines
3214 J. Williamson—Manufacture of alkalies
3215 J. Darling—Penholder, and means of supplying ink to pens
3216 P. Sauderson and R. Sanderson—Manufacture of yarns and machinery employed therefor
3217 G. Haseltine—Looms and shuttles for weaving
3218 R. Ackroyd and W. Maud—Screw gill boxes for preparing wool and other fibrous substances
3219 G. H. Phipps—Means employed for propelling steering, and manœuvring vessels, &c.
3220 F. W. Turner—Reaping machines
3221 F. Lane—Photographic pressure frames
3222 J. C. MacDonald and J. Calverley—Printing and cutting into sheets rolls of paper
3223 J. Freer—Machines for planting grain and seed and seed feeder and meter for planting machines
3224 W. Clark—Electro-magnetic apparatus for obtaining motive power

Dated December 7th, 1866.

3225 W. Guest—Manufacture of cords or ropes from strands of fibrous material or wire, and machinery employed in such manufacture
3226 A. C. Fraser—Apparatus used in the manufacture of gas
3227 J. Lowe and P. Lowe—Machinery to be employed in printing paper, &c.
3228 W. Clark—Detaching hook
3229 W. A. Richords—Receptacle for tobacco
3230 J. McGlashan—Cover for securing and labelling bottles
3231 R. Smith and J. Romage—Yarns used for weaving textile fabrics, and machinery employed therefor
3232 T. Gray—Preparation of bleaching materials
3233 C. E. Samuelson—Propelling vessels

Dated December 8th, 1866.

3234 H. C. Lucy—Connecting the ends of iron and other metal bands surrounding bales of cotton, &c.
3235 T. Chnloner and J. Billington—Construction of tools for graining, &c.
3236 W. Robertson and C. J. Waddell—Machines driven by human, animal, or other power having a reciprocating motion
3237 G. Haseltine—Machine for pegging bo ts and shoes
3238 F. C. Buisson—Employment in the marine of the buoys or imperial cupboards
3239 H. Southall—Buckles
3240 W. H. Bigglestone—Ships' capstans
3241 J. Davies—Parallel rulers
3242 W. Warren—Pumps
3243 W. Richards—Firearms and cartridges
3244 H. Dine—Breech-loading firearms
3245 A. S. Stocker—Bottles and other receptacles, and their stoppers, &c.
3246 F. Armstrong—Sewing machinery

Dated December 10th, 1866.

3247 W. F. Smith and A. Coventry—Tool holders and cutters, &c.
3248 C. E. Brooman—Studs or nails for upholstery and other purposes, and apparatus employed therein
3249 W. C. Naugle—Armour plating
3250 J. Tolson—Twisting threads of wool and other fibrous materials.
3251 W. Hopkinson—Combing wool and other fibrous substances
3252 E. J. Warmington—Breech-loading firearms, and cartridges to be used therewith
3253 W. E. Newton—Breech-loading fire-arms, and cartridges and bullets for the same

Dated December 11th, 1866

3254 R. Clayton, J. Raper, J. Goulding, and W. Howarth—Looms for weaving
3255 W. Hopkinson—Sheep shears
3256 C. E. Brooman—Railway carriages and waggons
3257 C. E. Brooman—Looms for weaving
3258 E. S. Catbels—Conveying and regulating the supply of gas
3259 W. E. Newton—Cleaning the outer surfaces of steam boiler tubes
3260 J. Varley—Assorting silk and other fibres
3261 T. H. Cooper—Railway buffers

Dated December 12th, 1866.

3262 R. B. Boyman—Applying jets of steam by action and reaction to propel vessels and aerial conveyances, &c.
3263 J. Studley and E. Jackson—Combing wool or other fibrous substances
3264 T. Jones—Window sashes and frames
3265 S. Chatwood—Safes and key boxes
3266 V. Gallet—Manufacture of steel
3267 J. Robinson and J. Smith—Applying motive power to saw frames

Dated December 13th, 1866.

3268 H. Wrenn and J. Hopkinson—Dressing slates
3269 I. Baggs—Manufacture and treatment of hydrochloric and nitric acids
3270 J. Robinson—Ornamenting glass
3271 J. Murphy—Vehicles to be used on railways
3272 P. Heyns—Making steam boilers for marine and other purposes
3273 C. E. Brooman—Treatment of lead and argentiferous litharge
3274 C. Sinibaldi—Stoves for cooking, &c.
3275 J. T. Kent—Taps for drawing off liquids
3276 J. H. Grell—Construction of steam ships, &c.
3277 W. Wood and J. W. Wood—Fibrous yarns
3278 J. H. Pepper and S. F. Piebler—Apparatus and automatic figures capable of performing various gymnastic feats
3279 H. W. Ripley and T. Barker—Steam boilers and applying heat thereto
3280 J. Steeson—Manufacture and remelting of iron and steel
3281 C. C. Adley—Telegraph standards and insulators
3282 W. R. Lake—Scrubbing machine

Dated December 14th, 1866.

3283 A. de Neviers—Sledges
3284 L. Lindlay and Taylor—Sewing and embroidering machines
3285 F. B. Baker and L. Lindley—Stretching and finishing lace, &c., and machinery employed therein
3286 T. Andrew—Construction of pulleys and lifting gear for raising and lowering weights
3287 A. W. Hosking—Facilitating communication between passengers and guard on railways
3288 H. Brinsmead—Construction of pianofortes
3289 A. V. Newton—Steam motor
3290 A. Woods—Hammock cot, and means for suspending the same
3291 T. Berney—Bending bars and plates of metal

Dated December 15th, 1866.

3292 T. V. Morgan and E. Hyles—Manufacture of crucibles and other hollow articles from plastic materials
3293 F. W. Reeves and J. B. Muschamp—Explosive substance
3294 W. H. Burroughs—Marking boards for billiards, &c.
3295 C. Randolph—Propelling vessels
3296 T. Hoey—Measuring and controlling the supply of water for closets and general uses, &c.
3297 S. Chatwood and J. Sturgeon—Hammers and mechanism used therewith
3298 J. P. Gillard—Attracting, exciting, and distributing in various directions rapid successions of electric currents derived from the voltaic pile or other electric apparatus
3299 G. Bertram—Machinery to be used for the manufacture of paper
3300 E. Meldrum—Gas for illuminating and heating purposes
3301 A. Rollason—Blasting cartridges and fusees
3302 D. Kirkwood—Breech-loading firearms
3303 J. W. Swan—Treatment of gelatinous tissues of gelatine and gum, &c.
3304 W. E. Newton—Welding steel to malleable iron, &c.
3305 W. Campion—Linking, joining, turning off, and clearing looped or knitted fabrics
3306 J. Symm—Sheep and cattle racks
3307 C. E. Brooman—Preparation and application of certain fatty bodies
3308 W. Clark—Carburetters

Dated December 17th, 1866.

3309 J. Haworth—Steam boiler and other furnaces
3310 G. A. Neumeyer—Gunpowder for mining purposes
3311 H. Hall—Preparation of size and apparatus connected therewith
3312 C. Mole—More expeditious and effectual attachment of skates to boots or shoes
3313 E. Howell and T. Hardy—Horse rakes
3314 A. V. Newton—Construction of elevator
3315 G. Nimmo—Shovels and spades
3316 M. Weber—Firearms
3317 W. S. Mappin—Breech-loading firearms, &c
3318 W. Wood—Breech-loading firearms
3319 J. Baker and J. Imray—Cable stoppers
3320 F. N. Meixner—Turbines

Dated December 18th, 1866.

3321 J. M. Gray—Steering apparatus
3322 W. E. Gedge—Carding wool
3323 J. W. Cusack—Facilitating artillery and rifle practice at long distances on short ranges
3324 G. Speight—Shirt fronts or dickeys and chemisette fronts
3325 J. Macintosh—Breech-loading guns and projectiles
3326 L. Schad—Treating aniline colours for dyeing and printing
3327 W. R. Lake—Mode of rendering paint uninflammable
3328 W. R. Lake—Nails, and machinery for manufacturing the same.
3329 A. V. Newton—Spinning yarn
3330 T. Titterington—Apparatus and material used in the imitation of woods and marbles, &c.

Dated December 19th, 1866.

3331 G. Davies—Cylindrical printing presses
3332 S. Buxton—Stench trap
3333 J. Goodfellow—Moulding the moulds of wheels &c., without patterns
3334 R. Bodmer—Securing the nuts of bolts
3335 S. Wilson—Fastening for baling bonds
3336 M. Henry—Centrifugal pumps, &c.
3337 S. Perry and J. J. Perry—Inkstands
3338 M. H. Simpson—Prevention of sea sickness
3339 F. Hayman—Breech-loading firearms

Dated December 20th, 1866.

3340 T. Schofield—Raising the pile on fustians and other cotton fabrics
3341 W. Gilbey—Treating bottle corks
3342 G. B. Finch—Improvement in the feeding apparatus in cotton gins
3343 W. Chapman—Means employed in beading the uppers of boots, &c.
3344 W. E. Gedge—Locomotive machinery working without the aid of steam
3345 D. A. Graham—Steam and water traps, &c.
3346 T. Walker and T. F. Walker—Taking soundings
3347 W. Baker—Means for lighting fires
3348 S. Parry—Composition for the coating of the bottoms of ships and other vessels
3349 E. Dorsett—Removing tar, &c., from one place to another
3350 S. Belfield—Elastic and ribbed fabrics
3351 J. Baker—Thermo-electric and magnetic apparatus
3352 T. Whitby—Vessels of war and other structures requiring to be rendered shot proof
3353 S. Hall—Gossamer hat bodies
3354 W. E. Newton—Effecting the cumbustion of substances in a pulverulent state
3355 A. V. Newton—Compound for coating ships' bottoms and other surfaces
3356 R. L. Martin—Breech-loading firearms
3357 C. Lungley—War ships, &c., and fitting and working them
3358 T. Huckvale—Cleaning knives
3359 C. Norrington—Treatment of substances containing phosphate of lime
3360 W. R. Lake—Coupling for railway carriages
3361 W. R. Lake—Digging potatoes

Dated December 21st, 1866.

3362 R. Hall and S. S. Hall—Winding yarn and thread
3363 J. Anderson—Obtaining motive power
3364 W. H. Harfield—Propelling vessels
3365 W. Rowan—Cleaning and preparing flax, &c., and reducing the same to tow
3366 G. Allix—Raising and lowering window blinds &c.
3367 M. Weber—Setting steel pens
3368 J. Howard—Mowing and reaping machines
3369 S. Jacobs—Preparing wood and other materials preparatory to graining the same
3370 B. Browne—Camp or folding bedsteads
3371 W. Clark—Producing a draught in furnaces, and purifying the smoke therefrom
3372 W. Clark—Screw valves

Dated December 22nd, 1866.

3373 J. Sloper—Obtaining motive power
3374 A. Shanks—Metallic hoops
3375 F. Northall and R. Turnley—Water tuyeres
3376 H. Goodfellow—Grinding clay and such like substances
3377 A. S. Ayre and H. H. Ayre—Drying wheat &c.
3378 J. Rhodes, W. S. Rhodes, and J. Rhodes—Rag grinding machines
3379 S. Mitchell and J. Mitchell—Venetian blinds, and mechanism to be used in connection therewith
3380 C. J. Wuhab—Straining liquids, &c.
3381 W. Clark—Boots and shoes
3382 J. S. Beuson and J. von der Poppenburg—Breech-loading firearms
3383 J. R. Cooper—Breech-loading firearms
3384 W. E. Gedge—Grinding wheat and other grain
3385 F. Beltzer—Apparatus to size the thread of cotton, &c.

Dated December 24th, 1866.

3386 H. A. Dufrené—Manufacture of the extract of madder
3387 F. A. Calvert—Carding and cleaning fibrous substances
3388 J. Toussaint—Cement
3389 J. Rodgers—Construction of drums
3390 R. Lewis—Steam boilers
3391 E. Allen—Cleansing casks and machinery employed therein
3392 S. F. Schoonmaker—Coating for paper, &c.
3393 R. H. Ashton—Producing printing surfaces and carvings from moulds obtained by the aid of photography
3394 C. Varley and S. A. Varley—Improvements in generating electricity

Dated December 26th, 1866.

3395 T. B. Jordan and J. Darlington—Applying hydraulic power to mining and other purposes
3396 A. Mackie—Distributing type and preparing type for distribution
3397 J. Fletcher and W. Carr—Sizing yards preparatory to weaving
3398 H. W. Shaw—Ladies' wearing apparel
3399 W. Brookes and J. Mayes—Production of needles
3400 B. Shaw and J. Appleyard—Safety bottle case

Dated December 28th, 1866.

3401 W. Bradburn—Treating refuse matters, etc.
3402 N. C. Franzen—Steering indicator
3403 C. D. Abel—Prevention of rot in potatoes and grapes, etc.
3404 T. Walker and T. F. Walker—Regulating the evaporating power of steam boilers, etc.
3405 W. Clark—Valves
3406 A. W. Makinson—Locomotive and marine engines
3407 E. Storey—Marine and other steam engines
3408 A. V. Newton—Drying apparatus
3409 W. H. Cutler—Cocks for stopping and regulating the flow of steam, etc.
3410 F. Watkins—Shaping metals for screw nuts and like articles
3411 H. B. Condy—Manufacture of chlorine
3412 F. Watkins—Shaping and forging metals into rivets, etc.
3413 W. Thomson—Actuating the points of railways
3414 E. F. Goransson—Casting rings for making tyres of railway wheels, etc.

Dated December 29th, 1866.

3415 J. E. Brown—Treating web fabrics and means employed therefor
3416 S. Smith and J. W. Jackson—Regulators for motive power engines
3417 W. Smith—Street sweeper
3418 A. V. Newton—Safety attachment to carriages
3419 H. Chamberlain—Manufacture of coke and charcoal, and ovens employed therein
3420 A. J. Adams—Locks and latches
3421 W. Simons and A. Brown—Dredgers
3422 J. Sintter—Improved sifter
3423 W. B. Berrey—Cleaning glass, etc.
3424 C. Harrison—Valves
3425 F. J. Manceaux—Breech loading firearms and cartridges for the same
3426 W. Wilby—Belts for driving machinery, etc.
3427 E. B. Sampson—Saucepans, etc.
3428 F. Leonhardt—Metallic boxes
3429 G. Haseltine—Fastenings for pocket books, etc.
3430 A. B. Ely—Nautical logs
3431 B. W. A. Sleigh—Hydrostatic rotatory motive power engines
3432 G. Payne—Manufacture of soap
3433 J. Napier—Preparation of food
3434 W. Clark—Fixing rails to the sleepers of railway
3435 C. Sheridan—Manufacture of oakum

Dated December 31st, 1866.

3436 W. Exall—Machinery to cut grass and corn, and to gather and bind the same into sheaves
3437 T. W. Couldrey—Trousers
3438 G. Shrewsbury—Heating apartments, etc.
3439 W. Loeder—Rails and part of the permanent way of railways
3440 T. W. Plum—Taking off liquids from casks, etc.
3441 H. Allman—Locks and keys
3442 A. Henry—Firearms
3443 J. H. Johnson—Advertising
3444 C. D. Abel—Seeding flax
3445 H. Gottheimer—Fur lined over boots and shoes
3446 J. T. Griffin—Calendar movements for clocks
3447 G. P. Pocock—Breech-loading firearms
3448 W. Clark—Hydrogen gas, etc.
3449 C. F. Flach—Extracting silver from lead
3450 L. G. Speyser—Mixing mortar, etc.
3451 J. Miller and J. Mitler—Elastic gussetts
3452 G. T. Bousfield—Effecting the cut-off in steam engines, etc.
3453 F. P. Warren—Cooking apparatus

Dated January 1st, 1867.

1 W. Wood and J. W. Wood—Fibrous yarns, etc.
2 W. Muir—Planing machines
3 A. D. Campbell—Bench planing machines
4 G. Stuart—Manufacture of combs, and machinery employed therefor
5 M. Henry—Evaporating and concentrating cane juice, etc.
6 H. A. Jones—Portable folding chair
7 H. W. Hart—Apparatus for combining advertising cards for public distribution
8 G. B. Woodruff and G. Browning—Button hole sewing machines
9 A. McGlashan and A. Brittlebank—Feeding paper to printing machines

Dated January 2nd, 1867.

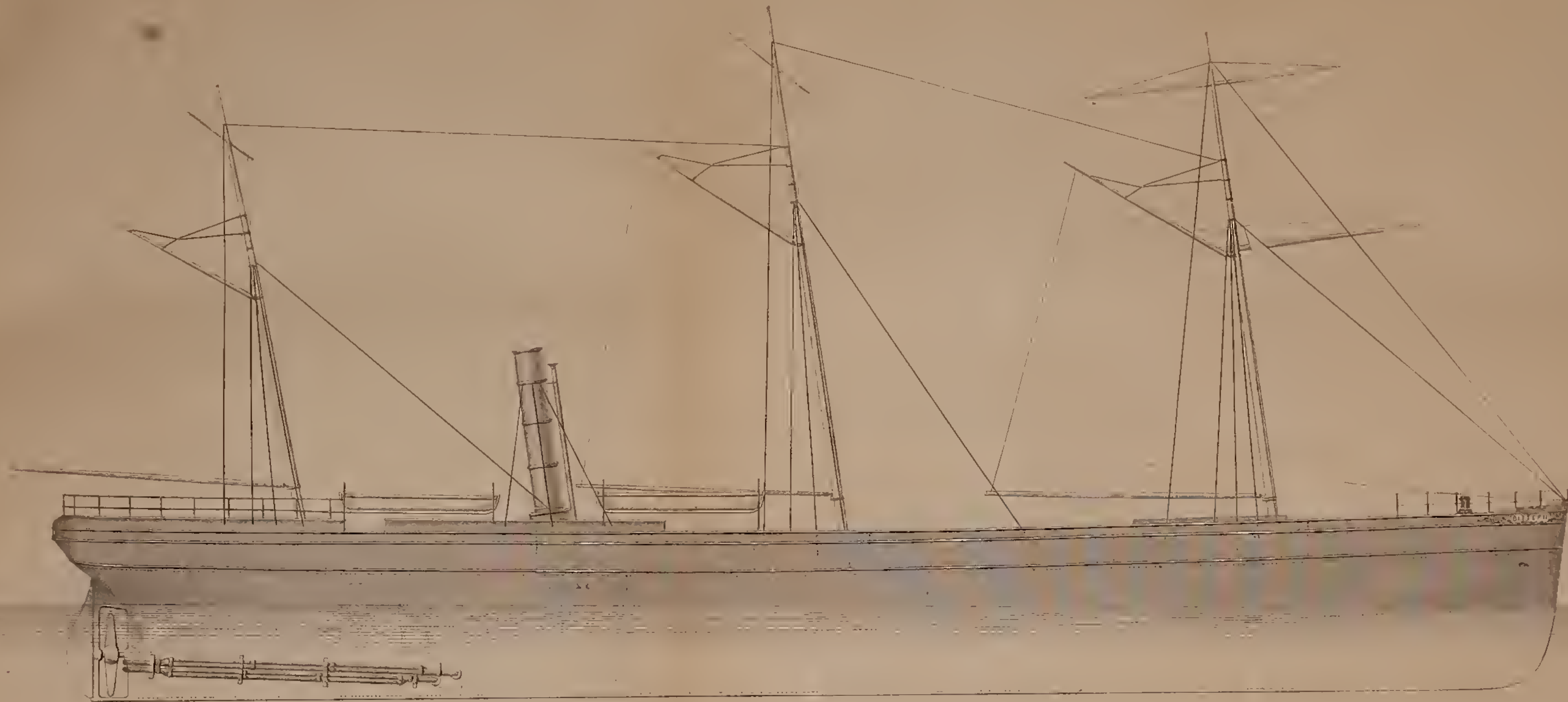
10 J. Plewis—Breech loading firearms
11 C. D. Abel—Obtaining power from the motion of a ship at sea for pumping, etc.
12 J. C. Ellison—Folding fabrics, etc.
13 A. Ward and C. G. Virgo—Scarfs

Dated January 3rd, 1867.

14 B. Nokes and T. Sanders—Lady's companion
15 J. W. Kenyon—Removing the scum from the surface of the water in steam boilers
16 G. B. Smith—Supports for the insulators of electric telegraphs, etc.
17 J. Cochshoot—Carriages, etc.
18 W. Chippindale—Coupling railway carriages to each other
19 J. K. Broadbent—Prevention of smoke from furnaces used for steam boilers, etc.
20 W. G. Helsby—Photographic pictures
21 W. Lamoreux—Applying teeth to saws

ERN"

W. Smith. C.E. direx



SIDE ELEVATION OF THE SCREW STEAM SHIP "BITTERN"

SHEWING ARRANGEMENT OF CONDENSERS.

0 5 10 15 20 40 60 80 100 120 140 160 180 200

SCALE OF FEET

RADIAL DRILLING MACHINE,

DESIGNED BY STEPHEN ALLEY,

CONSTRUCTED BY NEILSON BROTHERS, GLASGOW.

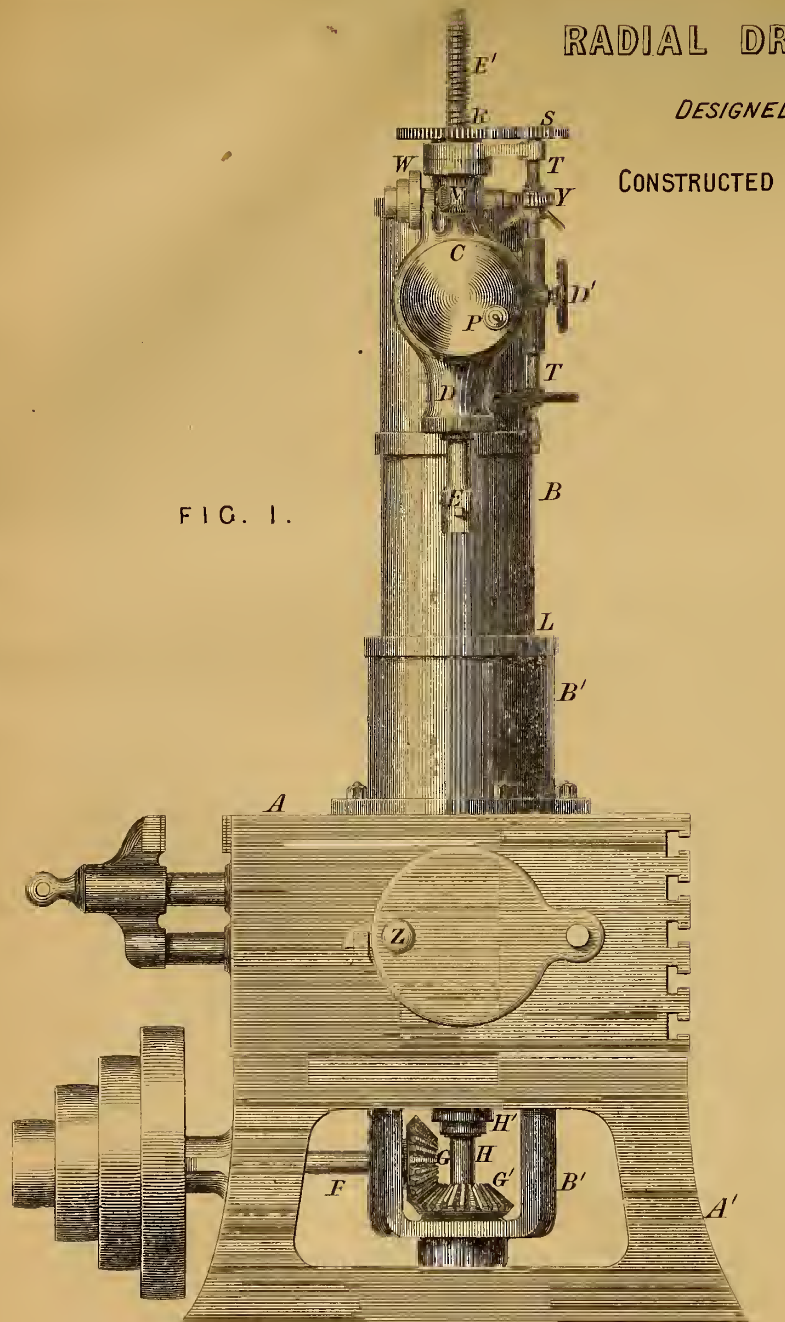


FIG. 1.

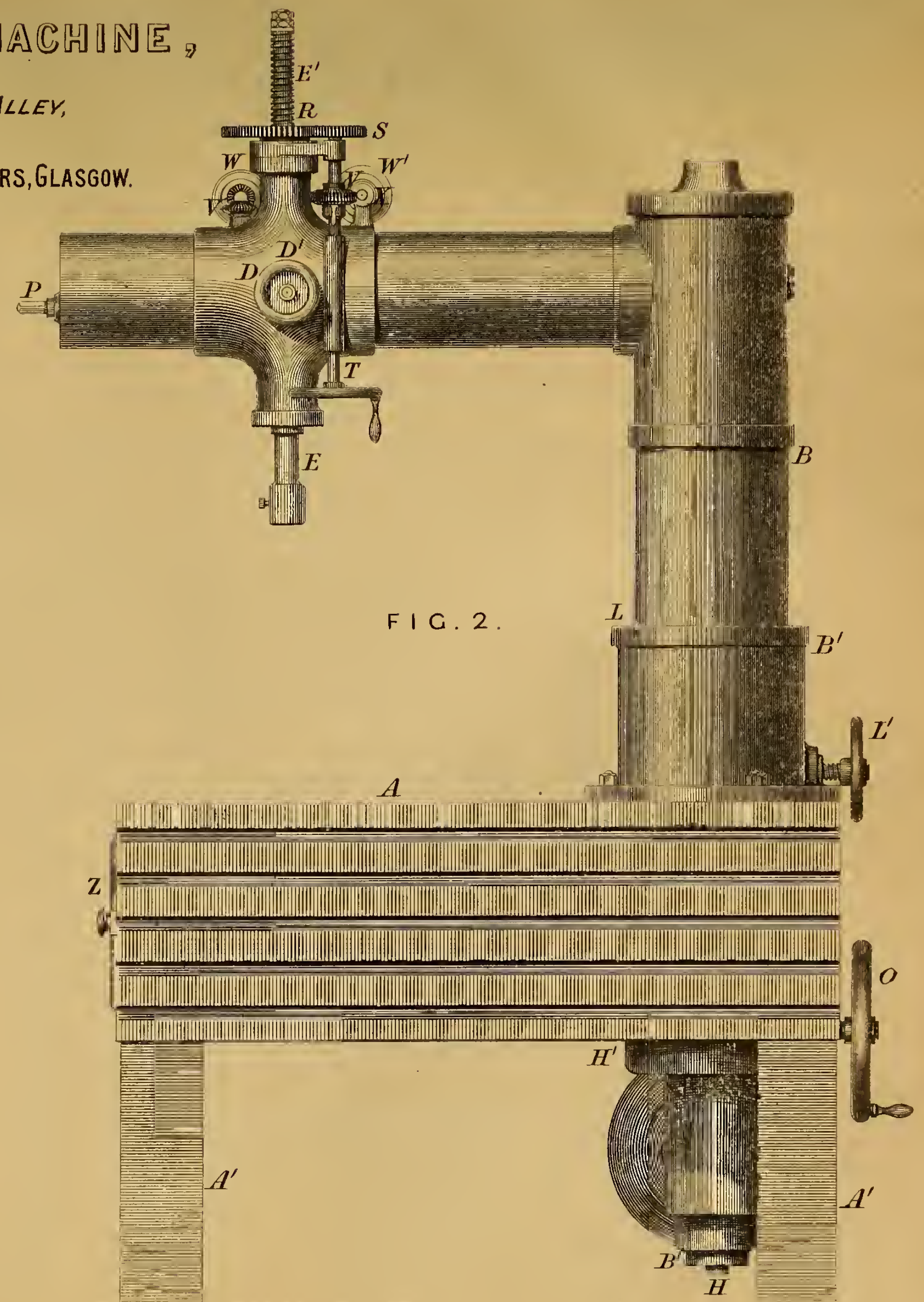


FIG. 2.

Scale of Feet.

W. Smith, C.E. direx.

THE ARTIZAN.

No. 2.—Vol. I.—Fourth Series.—Vol. XXV. From the Commencement.

1st. MARCH, 1867.

THE SCREW STEAMSHIP "BITTERN."

(*Illustrated by Plate No.* 311*.)

In The Artizan for last month we gave a notice of the performances of this steamship, and described the improvements introduced by Mr. Alexander Crichton on board the *Bittern*, and illustrated the subject with a copper plate engraving, showing as Fig. 1 a transverse section of the hull and machinery, taken about amidship, and as Fig. 2 a sectional plan view of the engines. We were unable then to give the further view necessary for rendering the subject of the notice complete and understandable, in consequence of the copper plate engraving not being ready in time.

We now supply the furthur illustration, which is comprised in the Plate No. 311, and also two outline diagrams of indicator cards taken from the engines on the 27th Dec. last.

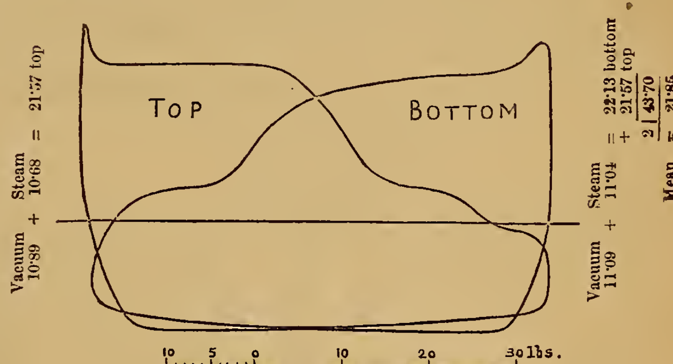
The side elevation of the ship given in Plate No. 311 shows the arrangement and disposition of the surface-condensing pipes, which, as previously stated, are of wrought iron, galvanised inside and out, 7in. diameter and $\frac{5}{16}$in. thick; there are two such pipes belonging to each engine, connected to the double end of a junction pipe, by which they are combined, and the single end of the junction pipe which enters the ship's side is suitably increased in diameter to be equal to the areas of the two condensing pipes. At the stern each pair of condensing pipes of each engine is similarly connected or combined by means of a junction pipe, which is curved so as to pass through the screw opening clear of the propeller, and a similar junction is effected on the opposite side of the ship's stern to that shown in the illustration. In this way the exhaust steam is conducted by means, first of the in-board connection with the external junction pipe, which is forked, into the two galvanised wrought iron pipes which pass along the ship's side aft to another junction pipe, and thence, through a single piece of pipe, which passes round the stern (before the screw) through the screw opening, and from thence through the two condensing pipes (as on the other side) into the junction piece, through which the water resulting from the condensation of the steam is conveyed in-board to the hot-well, to be collected and used for the purpose of feeding the boilers, as will be seen on reference to the two views in Plate No. 310, and the side elevation of the vessel with the position of the machinery and internal apparatus and connections (as dotted in), in the accompanying Plate No. 311.

In connection with the former notice of the performances of this ship and her machinery, first with the injection condenser, and afterwards with the surface condenser, we now give the outline diagrams of the figures produced by the indicator from cards taken from the fore and after engines of the *Bittern* on the 27th December last. On making a summation of these results we find the mean of the top and bottom figures taken from the fore engine to be 21·85lbs., and the mean of the after engine to be 21·65lbs., the steam pressure being 20lbs. in the boiler, the vacuum gauge showing 27ins., and the engines making 47 revolutions

The *Bittern* has since the date of the experiments previously recorded been engaged in running between Liverpool and Antwerp, and has experienced during the late gales very severe weather in her passages backwards and forward. The description of coals employed on board the *Bittern* during these voyages is very different from the Welsh coals ordinarily consumed when engaged in the Cork and Bristol, or Cork and Cardiff trades, and as an illustration of the differences in value which belong to the quality of the fuel, we may refer to the fuel consumption whilst on the Liverpool and Antwerp line, and compare it with the duty done by a ton of Welsh steam coal of good quality. The mean consumption of Welsh coal per hour per indicated horse-power, was, with the common

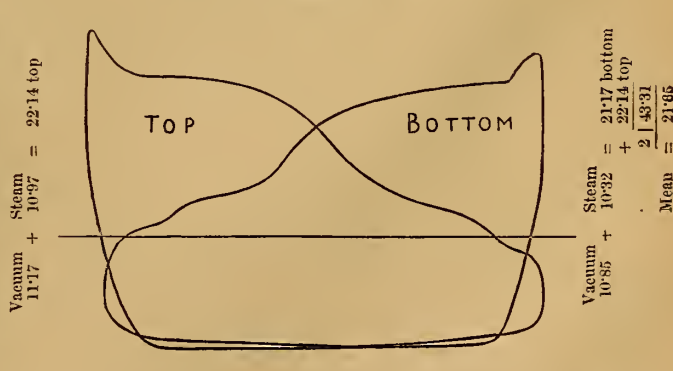
Steam, 20lbs.
Vacuum, 27ins.
Revolutions, 47.

FORE ENGINE.



condenser, 3·89lbs., and this quantity was reduced to 2·81lbs. with the surface condenser, as stated at p. 26 *ante;* now, on reference to the logs, when the same ship was formerly on the Antwerp line, and working with the common condenser, we find the coal consumption was 17cwt. per hour, or 5·31lbs. per indicated horse-power, whilst, during her most recent voyages since being altered, her coal consumption was found to be 16cwt. per hour, or 3·71lbs. per indicated horse-power.

AFTER ENGINE.



The boilers were examined a few days ago in Liverpool, and were found to be perfectly free from scale or hard crustaceous deposit; neither were there any signs of galvanic action or corrosion, such as are commonly exhibited when surface condensers with brass or copper tubes are employed.

On the whole, the performances of the *Bittern* are well worthy of being recorded, and as considerable interest attaches to the results of the altera-

* [Note.—By an inadvertence the plates relating to this subject were stated in last month's Artizan as Nos. 309 and 310; the numbers are 310 and 311. No. 310 was given last month. No. 311 is published herewith. Ed. Artizan.]

tions made by Mr. Crichton in the engines and condensing apparatus of that ship, we have thought it right to give the details somewhat *in extenso*, and we propose to again refer to the performances of the *Bittern.*

During her recent voyages off the north and east coast of England, the *Bittern* met with severe weather and floating ice, and in entering and leaving the ports between which she was trading, she suffered more than the average amount of rough usage, and the external pipes for effecting the condensation of the steam were subjected to as much risk from external injury as they are ever likely to incur; yet, not the slightest leakage or derangement of the condensing apparatus occurred; nor are the condensing pipes, placed where they have been in the *Bittern*, at all exposed to external injury, from any of the many well known risks to which such ships are liable, even to taking the ground and healing over on their beam ends. This will be understood on referring to plate No. 310, where the midship section, or section of greatest breadth, is indicated by the dotted lines right and left of the keel.

Mr. Crichton does not propose to confine himself to the precise mode of arranging and placing the condensing pipes externally, as shown in the sheet illustration plate No. 311, even in the case of screw steamers, whilst in case of applying his invention to a paddle steamer, modifications would necessarily have to be introduced to adapt the arrangement to the engines and to the external form of the ship, and the different character of the propeller employed.

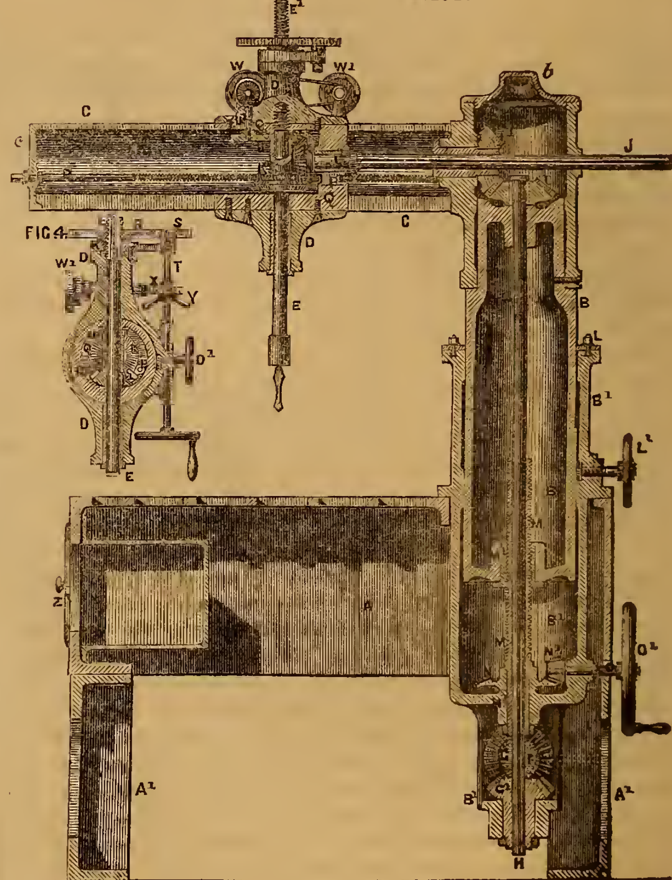
RADIAL DRILLING MACHINE.

(*Illustrated by Plate* 312.)

Engineers and machine makers are fully alive to the importance of having the best and most generally useful machine tools in their workshops and factories, and we have from time to time noticed many of the newest and most practical designs of machine tools suited for the various branches of engineering construction in our workshops, as they were produced by the leading tool-making firms of the day, both in England and Scotland; and we now select for notice an example of a new form and construction of radial drilling machines, manufactured of various sizes, for particular classes of work, by Messrs. Neilson Brothers, of the Albert Works, Glasgow—the invention of Mr. Stephen Alley of that firm,—which strikes us as possessing so many new and substantial improvements as must at once command for these tools a place in every workshop, and cause them in a great measure to supplant the present fixed-arm vertical drilling machine.

Figs. 1 and 2 of our plate engraving, No. 312, show a longitudinal and transverse elevation respectively to an inch scale of the machine adapted for the lighter class of work required in the finishing and erecting shops of engineers and machine-makers; such as for boring the bolt-holes in the covers of cylinders, pumps, valve chests, and in pistons, &c., in which there are many holes to be bored, which could be done better and with a greater saving of time, by one adjustment and fixing, by shifting the radial instead of re-setting the article in the usual fixed-arm vertical drill, the articles being generally bolted to the horizontal top or vertical sides of the bed or table A, having longitudinal rows of holes, or T shaped recesses, for the purpose. The table is of an open rectangular form secured to the top of two end standards, A^1, bolted to the floor of the workshop; the whole forming the main frame for supporting the pillar B, B^1, and jib C, of the machine. A parallel-acting vice is attached to one side of the table, A. The upper part of the pillar, B, is of a hollow cylindrical form, truly turned on the outside, so as to be supported and fitted to move telescopically and vertically, to the extent of 12in., and swivel horizontally to any angle, within a deep-bored bearing formed in the upper end of the hollow cylindrical lower or basement part B^1, of the pillar, passed down through a recess in the upper face at one end of the table, A, to which this piece is firmly secured by a strong flange and screw bolts. The jib C, which is rigidly screwed to the upper end of the pillar, B, by a socket or tight deep turned and bored spigot and faucet joint, is also turned cylindrically on the outside, and fitted with the long bearing and sliding carriage or saddle, D, carrying the boring spindle, E, revolving in long bushed bearings formed at the upper and lower parts of the saddle, which imparts great steadiness to the saddle and spindle, and gives them an available radial traverse upon the jib of from one to three feet. The jib is cast with a core or hole eccentric to the outer circumference towards the top, so as to make the metal thicker along the under side; and in some cases, where large radiating jibs are employed, the metal is made gradually thicker towards the pillar, with a slot or recess along the upper and lower side, for the boring spindle to pass through and traverse along.

FIG. 3.



In the annexed wood engraving, Fig. 3 is a longitudinal section, to a ¾in. scale, of the same machine, corresponding to Fig. 1 of the plate; and Fig. 4 is a transverse section of the jib and saddle, showing the internal construction and mode of actuating the several parts not seen in the elevations on the plate. The first motion shaft F is driven in the usual manner from a driving shaft revolving in pendant bearing brackets overhead, carrying the fast and loose driving belts, pulleys, and reversing fork arrangement, and one speed pulley corresponding to the one on the overhanging end of the shaft F, which are all furnished along with the machine. The shaft F revolves in a long bush bearing formed on one of the standards A^1, and in a journal and bush bearing at the inner end, fast on the lower part of the fixed cylindrical basement piece B^1, of the column or pillar, and it gives motion by the pair of mitre wheels G G^1, to the vertical shaft H, revolving in bushed bearings formed in the true vertical axis of the hollow pillar B B^1. The shaft H, in turn gives motion by the pair of mitre wheels I I^1 to the horizontal shaft J, revolving in bushed bearings within the jib C; the axis of that shaft is in the same vertical plane as the axes of the shaft H, jib C, and boring spindle E, which is actuated by the pair of mitre wheels K K^1. By this means the strain of boring, in

whatever angular position the jib may be placed, has no tendency to twist or turn it and the pillar B, after being set or fixed by the dovetail headed screws and annular friction collar L, fitted on the top of the basement B^1 of the pillar, having a key inserted into a vertical grove in the pillar B, so as to be easily set to any angle and finally fixed, when vertically raised to its required height, by the pinching screw and hand wheel L^1. The pillar B carrying the jib C, is raised and lowered by the turning of tho hollow screw spindle M, working in the deep brass screw nut, M^1, at its lower end, the screw M being turned in this case by the bevel wheels N, N^1, and the spindle O and hand wheel O^1, so as to revolve without vertical motion in the fixed bearing, H^1, of the basement piece B^1, and upon the shaft H, which rises and falls through it and its own actuating wheel G^1, coupled and sliding by a feather and a groove along the shaft, and the pillar B, rises and falls with the shaft, by the turning of the screw M. The saddle D and drilling spindle E are traversed along the jib by the horizontal screw P, working through the screw nut P^1, fixed to the traversing block Q, screwed to the saddle D, at the parts working out through the guiding slots of the jib C, the screw being worked by a hand crank or wheol on the square end projecting out through the end of the jib. This block Q also carrios the traversing bearing J^1, of the shaft J, so as to retain the wheels K K^1 in working gear, while the shaft is being traversed through the bush boss of its actuating wheel I^1, coupled by a feather and slot, the free end of the shaft J passing out through a hole at the back of the head of the jib and pillar. The saddle D is fixed in its position upon the jib C, when properly set by the pinching screw and hand wheel D^1. The boring spindle E is fed or screwed down, or raised to the extent of a traverse of 9in. by the long tubular screw E^1, mounted on the upper part of the spindle E, made small to revolve within the screw tube, which is retained in position by a shoulder at the lower side, and a friction washer, tightenod up by double nuts on the top. The screw E^1, Fig. 4, is actuated by the screw collar nut R^1, and spur wheel R, revolving in a bearing in the upper part of the saddle D, and set in motion by the spur pinion S, at top of the spindle T, fed or turned by the hand wheel T^1. But, when this spindle is fed by the machine itself, the motion is transmitted from the long boss of the bevel wheel K^1, which actuates the spindle E by the two small spur wheels U on the short vertical shaft U^1, which by the small bevel wheels give motion to the short tranverse shaft and cone pulley W which in turn by a strap transmits its motion at various speeds to the shaft of the cone pulley W^1, and by a screw on its front end working into the small screw wheel X, revolving loosely upon an enlarged conical part of the light vertical spindle T, actuates it instantly at pleasure by a slight turn of the hand screw Y, which causes the wheel X to drive the shaft by friction on its conical bearing surface.

The general advantages will be evident on reference to the illustrations above described. The hollow cylindrical construction of the pillar and jib is a superior distribution of the metal for giving the greatest amount of strength and rigidity; and we would augur greater durability also, from the more judicious use of large and long turned bearing surfaces. The greater part of the machine is itself made by machine tools. The simplicity of the tool is remarkable; the advantage afforded by enclosing most of the working mechanism within its own framing, so as to protect it from dust and injury, is important, while the working parts are easy of access for lubricating, cleaning, or removal by the lids *b* and *c* of the pillar and jib respectively. The boring spindles are made of the best steel, and the driving bevel wheels and all the gearing of the feeding motion and the saddle are all made of malleable cast-iron; an additional convenience is afforded to the machine by the adoption of a small iron box, Z, bolted to one end of the table, A, for holding the drills and other small tools connected therewith.

The larger designs, for heavy work, have no table, but, instead, a sole plate, bolted to the stone foundation, with a strong fixed pillar or collar, cast or bolted thereon, within which the movable pillar, B, is made capable of being raised and lowered by hand, or power, by a friction clutch arrangement connected with the lower end of the hollow screw spindle, M, either with or without the addition of the gearing connected with the hand-wheel, O^1, for actuating the screw by hand; and when long radial jibs are used, the actuating shaft, J, is made telescopically, so as not to project far out beyond either end of the jib.

The makers of these machines remind us that it is a well known fact that a man working a radial drill can turn out twice the amount of work that it is possible for him to do with the ordinary fixed-arm vertical machine, from the simple reason that he can always koep the radial machine in motion. He sets one job while the previous one is being bored, shifting his drill to suit his work—not his work to suit the drill, as is the case with the fixed-arm vertical, by the use of which so much time is wasted, inaccuracies occur in the settings, and the holes are not bored in unison one with the others. The great drawback heretofore set forth against the more general adoption of radial drille has been their high price as compared with the ordinary fixed-arm vertical drilling machines; the large saving they effect in wages and space are, however, forgotten.

The accompanying engravings of these improved radial drilling machines will, it is hoped, be sufficient to convey their principal advantages and merits. The extreme simplicity of the tool cannot fail to be noticed; the smaller working parts are enclosed, and thus protected from injury, but they can at the same time be got at with the greatest facility. The spindle is in the same vertical plane as the centre lines of the jib and pillar, so that the drilling strain cannot tend to twist the parts. Great steadiness is imparted to the spindle by its long vertical bearing, and by the extensive bearing of the carriage or saddle upon the jib. To vary the hoight of the jib the upper part of the pillar to which the jib is fixed is adjustable in the lower part, and the fitting surfaces are cylindrical, whereby great steadiness in every position is obtained, whilst the jib can be swung round a complete circle horizontally, without requiring any additional appliances, and fixed rigidly at any angle by the hand whoel on back of column. In Figs. 1 to 4 the radius of the arm is 3ft.; lift of jib, 12in.; feed, 9in. deep.

We believe these machines will recommend themselves to all who value good tools.

BHORE GHAUT INCLINE.

About forty or fifty miles from the western coast of India rises to a height generally of about 2,000 feet above the sea level, the procipitous range of mountains callod the Western Ghauts of India.

The Continent of India abovo, called the Deccan, is then tolerably level for some distance, and afterwards gradually slopes down to the eastern coast.

On approaching the foot of this, as it appears, great step in the country, or gigantic range of cliffs, hills are seen of tho same height, but detached from it, and also others joined to it by spurs, which latter run out in a few casos to a considerable distance into the country below, called the Concan.

Advantage was taken of these spurs to obtain as long, and consequently, as easy a gradient on to the table land abovo, as possible. The face of this table land appears as if broken up into wild and rugged confusion, ravines penetrating deep into it, and other hills rising again in places, high above it, and at the same time nearly precipitous above the country below.

The greater part of the Ghaut district for the months during and after the rains, is covered with thick verdant foliage, presenting a great contrast to the scene afterwards in the hot months, when all is withered and dried up. The Great Indian Peninsula Railway ascends the Syhadree or Ghaut range, in two places, at the Thul Ghaut for that portion of the line to the north-east, joining the East Indian Railway from Calcutta at Jubbulpore, and on which portion of the line is the branch to Nagpore, and also at the Bhore Ghaut, the subject of this paper, in a south-east direction, and meeting the line from Madras, at Raichore.

This line was commenced in 1849, and at the present time about 784 miles of it are open, and 489 moro aro under construction.

Before these two inclines were decided upon to be constructed, many other points in the Ghaut range, such as the Malsej, were examined by Mr. J. Berkeley, Chief Resident Engineer, and his staff; it was proposed at first to ascend at the Malsej only, the railway then to branch off to the north-east and the south-west.

All these places, however, amongst them the Kussoor, proved to be nearly impracticable, owing to the abruptness there of the Ghauts, the length obtained not being sufficient to give a gradient easy enough to be used by locomotives. In many of them the great depth of the valleys to be crossed would have necessitated works on a very great scale, both as regards the length of the tunnels and height of the viaducts. The heights of these summits above the sea, are nearly the same: the Thul being 1,912, the Bhore 2,037, the Malsej 2062, the Kussoor 2,149 feet. The examination for the Bhore Ghant incline was commenced in 1852, and the first line laid out, included an incline of 1 in 20 for $1\frac{3}{4}$ miles, to be worked by a stationary engine. Its length was $13\frac{1}{2}$ miles. In 1854, however, another line was laid out, and this having a gradient not steeper than 1 in 37, made the incline practicable for locomotive purposes. The introduction of the reversing station, flattened the gradient considerably, improving also the position of the line, by bringing it to the level of the village of Khandalla, where there are barracks for troops. This is the line constructed. It is 15 miles 68 chains long, and the height surmounted by it is 1,831ft. The contract for the construction of the incline was let first in 1855, to Mr. F. Faviell, and the upper portion, from Khandalla to the locomotive depôt at Lanowlee on the summit, was opened in 1858, the works on it being very light. At the same time a temporary line was opened from the foot of the incline to Campooly, where the mail road ascends the Ghaut, and which is very steep; the through traffic was carried on in this manner until the opening of the incline throughout in April, 1864. Mr. Faviell, however, relinquished the contract in March, 1859, and it was carried on by the Company's Resident Engineers, Messrs. S. Adamson and G. Clowser, departmentally for eight months. The works were again let to Mr. Solomon Tredwell, in November, 1859, who, however, died shortly after his arrival in India, when Messrs. Adamson and Clowser took charge of the works on behalf of Mrs. Tredwell, and successfully completed them, Messrs. A. West and J. Tate being resident engineers.

There are twenty-five tunnels and eight viaducts on this incline, the lengths and heights of which are as follows:

No.				No.			
1	Tunnel	66	lineal yards.	14	Tunnel	99	lineal yards.
2	„	132	„	15	„	87	„
3	„	121	„	16	„	198	„
4	„	123	„	17	„	55	„
5	„	121	„	18	„	63	„
6	„	143	„	19	„	101	„
7	„	286	„	20	„	66	„
8	„	291	„	21	„	71	„
9	„	282	„	22	„	280	„
10	„	44	„	23	„	247	„
11	„	140	„	24	„	341	„
12	„	44	„	25	„	66	„
13	„	437	„				

No.					
1	Viaduct,	8 fifty	feet arches,	127	feet high
2	„	6	„	95	„
3	„	4	„	74	„
4	„	4	„	94	„
5	„	8	„	163	„
6	„	6 forty	„	85	„
7	„	4 thirty	„	45	„
8	„	Reversing station		56	„

The masonry of the viaducts and bridges is of Blockincourse face work, with rubble hearting. The arches are of coursed rubble with Ashlar quoins. Some of these are of considerable height, that at Mhowke-Mullee, No. 5, being 163 feet above its footings. It is on an incline of 1 in 40, and on a curve of thirty chains radius. To show the precipitous character of the ground at this place, it may be mentioned that one abutment of this viaduct is only a few yards distant from the mouth of the longest tunnel. The viaduct at the reversing station is of a peculiar construction, owing to its having been formed for the two lines of railway, the one ascending and the other descending, for one-half of its length; the other half being level for both lines. Here the trains stop, and the front of the train becomes the back. Some of the tunnel arches under the banks are from 100ft. to 140ft. in length, and from 10ft. to 15ft. feet span, the ends of some of them ending in retaining walls. There was a large amount of retaining wall built in different places, as owing to the precipitous form of the cross sections, there was sometimes not sufficient span for the slope of the bank, and in some other places the railway had to be constructed half on vaulted arches built up against the face of the rock, and half in cutting. Masonry walls had to be built above the line in many places, to prevent the Boulders, with which some of the hills are covered, when dislodged by the rains softening the soil in which they are imbedded, from falling on the line, and also to preclude the great quantity of rain water from flowing into the upper ends of the tunnels. As might have been expected, heavy slips occurred continually, not only in the embankments, but also in some of the cuttings of loose earth, and quantities of rock, whose strata were inclined nearly vertical, the latter especially near Khandalla, broke away from the sides. In one case, near the foot of the incline, the side of the hill above the slope of a cutting, slipped in and refilled the cutting, only a short time before the opening of the line, and a covered way 110 yards long had to be made.

In the tunnels the work was carried on day and night by three gangs of men, and the rate of progress made was from two to six lin. yds. of heading, and three to eight of bottoming up at each face monthly.

In the headings, the heat was generally very great, and the air foul, as many of them were situated in ravines, shut in from any current of air; and at the lower end the gradient prevented the smoke from readily escaping. Three of the tunnels being through soft material, were lined with masonry, and the same had to be partially done in two or three others, when the rock which was passed through, proved to be faulty; but generally the rock was trap or basalt of the hardest description.

Specimens of the different kinds of crystals met with, are to be seen in the British and Jermyn Street museums, and are very rare and beautiful. The quantity of gunpowder used in the tunnels, rock cuttings, &c., amounted generally to five tons a day, or about 11,000 shots. In some places, the holes drilled for the shots were 7ft. deep, and 3in. in diameter, four men working the drill, the depth however was generally from 2ft. 6in. to 4ft. The working season in each year lasted only about eight months, the very heavy rain which always falls from June to September, and which is generally over 200in., prevented any work being done except in the tunnels, and it was with much difficulty any labourers could be induced to stay during that time. Cholera also twice broke out, and made frightful havoc amongst the workmen, creating such a panic, that none of them would stay during the remainder of those seasons, several also of the European foremen falling victims to the disease. A great difficulty arose in providing provisions and water, for the work and the use of the labourers, as in the working season there were from 25,000 to 40,000 assembled there from different parts of India.

The water had to be carried in skins on buffaloes, upwards from the river Oolassa at the foot of the incline, and downwards from the village of Khandalla near the summit. This might appear strange in a country with such a large rainfall, but it was found to be useless to attempt storing the water, owing to the porous nature of the soil.

Lime and sand, or mortar ready mixed, had to be carried to the works in the same manner, as also all materials used in centering, scaffolding, &c., and for temporary roads and the permanent way. A roadway was formed down the incline, as near as possible to the works, above or below them, and other paths from it to the different works; these being generally washed away during the rains, had to be renewed in many places every season. A siding of two miles in length was laid in the valley, from the main line in the Concan, to the contractors yard, below the third mile, for the conveyance of materials from Bombay. The permanent way was laid on transverse sleepers with longitudinal saddle bearers, 3ft. 3in. long, 14in. wide, and 3in. thick, secured to the joint sleepers by fang bolts, and supporting a saddle under the joint of the rails. The locomotive engines which work this incline are tank engines running in pairs. Their dimensions are:—diameter of cylinder 15in., and length of stroke 22in., on six wheels 4ft. in diameter. Heavier engines are now used, with ten wheels, six of which are coupled and the

four leading ones are on a bogie frame; a plate and description of these engines appeared in The Artizan volume for 1862.

Tho water supply for the reversing station, is obtained by pipes laid down the incline from Lanowly, at which placo, as well as at Kurjut at the foot of the incline, masonry *bunds* have been built across the rivers. A safety siding and telegraph office havo boen made at the 6½ milo, the points boing always open from the ascending line into the siding, in caso of part of a train breaking away, when ascending the inclino.

The gradionts of tho incline, are as follows, ascending from tho foot:—

Level	0 miles	33 chains		1 in 37	0 miles	28 chains
1 in 50	2 „	15 „		1 in 75	0 „	27 „
1 in 40	5 „	6 „		1 in 37	1 „	10 „
Level	0 „	10 „		1 in 330	0 „	23 „
1 in 42	1 „	11 „		1 in 40	0 „	51 „
1 in 43	0 „	31 „		1 in 50	0 „	41 „
1 in 40	1 „	46 „		1 in 40	0 „	63 „
1 in 50	0 „	39 „		Level	0 „	33 „

The curves upon it are

	Miles	Chains
Of 15 chains radius	0	22
Of 20 „ „	0	28
Betweeu 20 and 30 „ „	1	48
Of 30 „ „	4	37
Between 30 and 40 „ „	1	9
„ 40 and 50 „ „	0	71
„ 60 and 70 „ „	0	57
Of 80 „ „	0	78
Straight	5	33

ON VAST SINKINGS OF LAND ON THE NORTHERLY AND WESTERLY COASTS OF FRANCE AND SOUTH WESTERN COAST OF ENGLAND, WITHIN THE HISTORICAL PERIOD.

By R. A. Peacock, Jersey.

(*Continued from page* 28).

Chapter IX.

Julius Cæsar, Pliny the Elder, Procopius.

136. It will now be convenient to gather what evidences we can from "Cæsar's Commentaries on the Gallic War," and for the reader's convenience to follow them with an exact translation (in Article 145). It incidentally becomes necessary, in pursuit of our object, to identify, if possible, the localities of his sea fight witb the Veneti, and of Sabinus's battle wlth the Unelli and others. These events, I affirm, took place, the former near Guernsey, Herm, and Sercq., or perhaps Alderney; and tbe latter not many miles distant from (the present) Coutances. It is well known that Cæsar's skill in concise, correct, and graphic description (of everything occuring under his own personal observation) was all but equal to his transcendent skill as a General, and that his accuracy may be fully relied on. The object of course is, to gather what we can of the geographical state of the localities now under consideration, in his time. He was assassinated in the Senate House at Rome, on the 15th of March, B.C. 44, in the 56th year of his age, twelve years after his victory over the fleet of the Veneti.

137. His friend Aulus Hirtius, who appears to have written the eighth book on the Gallic War says in it: "It is evident amongst all, that nothing has been finished so diligently by otbers, as not to be surpassed by the elegance of the Commentaries, which are published, lest knowledge of such important events might be wanting to anthors, and are so much approved by the judgment of all; that occasion appears to be taken away from, not afforded to anthors. At which circumstance my wonder exceeds that of others, for others only know how well and correctly he finished them, but I also "know how easily and quickly." Some remarks will now be given on part of Cæsar's Third Book.

138. There can be no doubt that the country surrounding Dariorigum, which was near but not on the site of Vannes, as well as that city itself did at one time belong to the Veneti. For the custom of calling chief cities after the peoples, as Vannes from the Veneti or Vens, Nantes from the Nannetes, &c., began in tbe times of the the emperors, But it is not certain that the Dariorignm country belonged to the Veneti at all, in Cæsar's time. For we have seen that Ptolemy (A.D. 117 to 161) leaves a blank for the name of the owners of Dariorigum, which is difficult to understand if it belonged to the Veneti. And at any rate even if it was theirs in Cæsar's time, it is probable that they had much other territory; for Pliny the elder (who probably wrote within a century after the sea-fight with the Veneti), states that they had "almost two hundred islands." It will be convenient to give a literal translation of the passage.* After enumerating the Aquitanian Gauls, he says with respect to, "The seas about the coast; between the Rhine and the Seine is British; between it [the Seine] and the Pyrenees, is Gallic. *Very many islands* (*almost two hundred*)* belonging to the Veneti. are called Veneticæ, and in the Aquitanian Bay [*i.e.* the Bay of Biscay] Uliarius." These large possessions explain and corroborate the facts mentioned by Cæsar,† namely, that the authority of the Veneti was by far more extensive than that of any of the neighbouring states; that they had very many ships; that they surpassed the rest in naval knowledge and experience; that they possessed the whole of the few existing harbours; and that they had nearly all as tributaries who were accustomed to use that sea. I am trying to satisfy tho reader in this article, not only that we may not suppose that the sea-fight with the Veneti took place to the westward of Britanny; but on the contrary, that we must suppose that it took place close to some of the islands Alderney, Guernsey, Herm or Sercq. As they had nearly two hundred islands (some of which are still of considerable extent notwithstanding heavy losses of territory by sinking and washing away), we can understand that their ships, soldiers, and sailors may—indeed, must—have been away at one or more of the most important islands; for how can we suppose so warlike and energetic a people would have left all their islands ungarrisoned and unprotected? And this view is supported by the matters of fact that though Cæsar had his ships bnilt in the Loire,‡ *at some thirty miles distance only* from Dariorigum, the Veneti neither blockaded him in the Loire, nor destroyed his ships whilst building, or when built. Where, therefore, had they their "three hundred most well-equipped ships" which he mentions in Sec. XIV.? And where had they their soldiers? Doubtless most, if not all their ships, were at some or one of their many islands, namely, in that "Venetia," or portion of Venetian territory where it was evident that Cæsar was first about to carry on war—as he himself tell. in the latter part of Section IX. But the last part of that section is quite conclusive as to the locality of the sea-fight. We will quote its "The Veneti," he says, "fortify the towns; they bring corn from the fields into the towns; they collect ships as most numerous (quàm plurimas) as they can *into Venetia*, where it was evident that Cæsar was first about to carry on the war. They unite as allies to themselves at tbat war the the Osismii, Lexobii, *Nannetes*,§ Ambiani, Morini, Diablintes, Menapii; they send for auxiliaries from *Britain, which is situated opposite those countries* (eas regiones)." Observe, he distinctly says that Britain was opposite those countries, namely "Venetia," where Cæsar was first about to carry on the war. And clearly Alderney, Guernsey, Sercq, and Herm are "opposite Britain," but no part of the west coast of Britanny is so, nor any others of the two hundred islands. And I believe that it was in the neighbourhood of the three latter islands named, because Guernsey, Herm, and Jethou must have been then united together as one island, and must bave been far more extensive, and, therefore, more important, than Alderney, that the sea-fight took place. Tbere is a farther circumstance which appears to count for something. Why did not an author so correct and graphic as Cæsar call the Venetia in question "island, or islands?" The answer appears to be, because his word *countries* or *regions* is especially appropriate; for, as Diodorus tells us, at low water they had the peculiarity of looking *like peninsulas*; and we find Cæsar himself ‖ speaking of them as "*little tongues* and *promontories*."¶ They were not clearly and exclusively islands—a more neutral or comprehensive term was preferable; and Cæsar, who always used the best words for his purpose, calls them "eas regiones," which words fulfil the requirements of the case exactly.

139. The locality will be farther fixed and confirmed by other statements of Cæsar; while at the same time, in other ways, he throws much light on the present subject of enquiry. He speaks in section ix. of "the nature of the place," and that "they knew the foot-roads to have been cut up by estuaries." Now in restoring the probable ancient coast line in the first map, of course it was necessary to continue tbe rivers across the territory now lost. This was done by sketching their supposed courses along the deepest soundings, for it is well known that the river bed is the *lowest* ground in every cross section of a valley, except at the mouth or delta, where the level has been raised by deposit of mud brought down by the river itself. The land streams, brooks, and rivers, must, therefore, have run across the long space which, as Diodorus has told us, was dried by the ebb tide: and thus *estuaries appear on the map which necessarily cut up the foot roads.*

140. We learn in Section XII., that their towns were placed on extreme tongucs and promontories. Supposing that "hou" means a house, and, therefore, tbat its plural means a group of houses or a town, we shall

* Nat. Hist., Book 4, Section XXXIII (XIX), Valpy's edition.

* The Italics are the present writers. † Book 3, Sec. viii. ‡ Sec. IX.

§ Clearly the Nannetes, or people of Nantes, are not opposite Britain, and Cæsar cannot, therefore, have meant that the allies of the Gauls were opposite Britain, but that the countries (regiones), namely "Venetia," where Cæsar was about to carry on the war, were opposite Britain.

‖ Sect. XII.

¶ In some editions the word is "linguis," tougues; in others "lingulis," little tongues.

then have the various (present) islets or barren rocks, of whose names "hou" or "ou" forms part; identified as the former sites of towns. Captain Richards, R.N., chief of the Admiralty Survey of the Channel Islands' Seas, now in progress, finds that if the sea bottom was lifted 22 fathoms, the bottom would be dry at low water all the way from Guernsey to the continent, except one space of about a mile wide, which is two fathoms deeper. Suppose then, for the sake of the present argument, that the sea about and amongst the Channel Islands, as well as the islands themselves, were lifted 22 fathoms higher, we should have a state of things in accordance with Diodorus's description, and Jersey would have become an integral part of the continent. The remark of Cæsar at the end of Section XII. appears to be quite conclusive that the sea-fight did not take place on the west of Britanny. Because, if the Romans had only had to sail from one part of the west coast to another part of the same west coast, they could not have had "the greatest difficulty in sailing in an immense and open sea." While, on the other hand, they must have had that difficulty, in sailing from the mouth of the Loire to the northern Channel Islands.

141. The "shallows" which Cæsar mentions in Sections XII, XIII., are in perfect harmony with what Diodorus has said, and with the present argument. For if "a long space" was so shallow as to be dried at low water, as the latter assures us was the case, there must have been "shallows" and "great stones and ragged rocks," as stated at the end of Section XIII., and of very great extent too, and of course of a nature to be dreaded by his ships.

142. To the late Mr. Ahier the credit is due for the happy idea that "Cæsar's Promontories" are identical with "Diodorus's Peninsulas." And his valuable and suggestive work "Tableaux Historiques de la Civilisation de Jersey," and his lending me Abbé Manet's book in connection with the stumps of trees in the sea bottom together, first led me to study this subject. The same hypothesis which restores "Diodorus's Peninsulas," restores also "Cæsar's Promontories," and does a good deal more. For example, let us again take Section XIII. We are there informed that the towns "were built on extreme tongues and promontories," and taking the word "hous" as signifying *assemblages of houses*, we shall have towns firstly at *Lihou* and *Jethou*, at the restored Guernsey island; a town at Brec*hou*, another town at restored Sercq island, and another town, Bur*hou*, at restored Alderney island, to say nothing of the Ecre*hous* and Diro*u*illes. And the people at Jet*hou* town, may have produced Mr. Lukis's shell middings. All these hous, or collections of houses, would find themselves near the coasts of those restored islands, that is to say, "on extreme tongues and promontories," as the first map shows. The "shallows" are thus restored, because the vast tract left dry at low water, must in great part have been shallow at high water. By means of their many ships the Veneti carried away their effects, up the Estuaries I suppose, to towns in the interior, where the advantages they had in defending themselves are obvious. Amongst other reasons, because the Roman ships being in channels which were perhaps narrow, certainly narrow in some parts, the Gauls could attack them from both sides. It is observable that he mentions that the tides were *great*, which can with more propriety be said of the thirty feet tides of Guernsey, than of the tides on the west of Britanny, which are not half as great.

143. In Section XIV Cæsar finding that storming the towns in detail was labour in vain, resolves to wait for his fleet. And as soon as his fleet was seen by the enemy, about three hundred of their exceedingly well equipped ships ranged themselves in order of battle opposite the Roman ships. And the Romans ultimately won the sea-fight, chiefly by the stratagem of cutting the riggings of the Gallic ships with long scythes, which rendered them unmanageable. The affair of the sea-fight "was carried on in the sight of Cæsar and all the army, so that no deed of greater bravery could be concealed; for all the hills and higher places, whence there was a near view to the sea, were held by [Cæsar's] army." I think Cæsar and his army must have viewed this sea-fight from the heights of Guernsey, Herm, Jethou, and Sercq; or some or one of them—rather than from Alderney. Because the four islands named, are now, and must have been then collectively of considerably more importance and greater extent than Alderney, and therefore were more likely to be the chosen centre of the power of the Veneti. Compare the last part of Sec. XI with the last part of Sec. XIV, and it will be evident that Cæsar, his army, and the two fleets, were all assembled in some regions "opposite Britain," which must have been the Northern Channel Islands.

144. In Sec. XV some of the Gallic ships having been boarded by the Romans, the Gauls sought safety by flight, and the Romans ultimately captured or destroyed nearly every ship of the Veneti before night. In Sec. XVI we learn that the Veneti and the whole of the maritime powers were subdued, and Cæsar took a severe revenge.

In Sec. XI. we learn that Sabinus was sent with three legions to the Unelli, Curiosolitæ and Lexovii (which last people probably occupied the N.W. part of Calvados), to keep those peoples in check. That is to say, to interpose a cordon militaire between those three peoples and the Northern Channel Islands, and prevent help of any kind being sent to the Veneti.

In Sections XVII. to XX. inclusive we learn that Sabinus arrived in the borders of the Unelli, which people, as Ptolemy has established, were seated at and about Coutances, not many miles distant from the site of which city Sabinus must have fought and conquered Viridovix. In Sec. XX. we find that at one and the same time Cæsar was assured of the victory of Sabinus, and Sabinus of the naval battle. This mutual hearing of the two victories at the same time, seems to signify that they took place at no great distance from each other. Which circumstance favours the belief that the sea-fight took place near Sercq or Guernsey, which are only some forty miles distant from Ptolemy's harbour of the Crotiatoni in the territory of the Unelli not far from which Sabinus's battle took place, probably. If the notion of the sea-fight having taken place in the Bay of Biscay opposite Vannes (which some believe), were not already demolished, as I think it is, by the necessity of the locality being "opposite Britain," we have this farther objection to the neighbourhood of Vannes being taken as the locality. Namely, its distance from the Unelli. For the distance from the Unelli to Sercq is only about one sixth as far as the distance from the Unelli to the sea on the west of Vannes. Whence it follows that it would be extremely improbable that Sabinus and Cæsar should mutually hear of each other's victory at one and the same time, because in those days of no steam, a Roman ship could not sail (except by an improbable combination of favourable circumstances) from the Unelli by way of Usbant to the neighbourhood of Vannes—in the *same space of time* which would be required for another ship to sail in the contrary direction. For obviously, the winds and tides favourable to one ship, would be unfavourable to the other. Hence it is very probable that the battles took place *near* each other—as at Sercq and on the west of Coutances, for example. One ship could sail *a short distance* (chiefly along an estuary) in the same space of time which was required for another ship to sail in a contrary direction. This view is corroborative of the theory that the battles took place respectively, about some of the Northern Channel Islands, and near Coutances. To suppose the messengers between Cæsar and Sabinus, to have gone overland, appears to be quite out of the question. Because the distance is more than a hundred geographical miles in a straight line, and would have been through their enemies country. If we accept the Emperor of the French's statement that the battle took place on the east of Avranches, the distance would not have been much less.

We have thus endeavoured to draw fair and reasonable conclusions, from faithful translations.

The Emperor of the French, in vol. 2 of his most interesting "History of Julius Cæsar," page 147, arrives at the following conclusions: That the country of the Veneti *about Vannes*, would be the first attacked. That the Veneti gathered together all their ships, "no doubt, in the vast estuary formed by the river Auray, in the Bay of Quiberon," as he represents on Plate 12. And again, page 149, "We may admit that Cæsar started from the neighbourhood of Nantes, and directed his march to the Roche-Bernard, where he crossed the Vilaine, and arrived in the country of the Veneti." And page 150, "He encamped to the south of the Bay of Quiberon, near the coast, on the heights of St. Gildas," with his army. (See Plate 12) And page 156, respecting the scene of Sabinus's contest with the Unelli: "He (Sabinus) established himself on a hill belonging to the line of heights which separates the basin of the sea from the Celune, where we now find the vestiges of a camp called Du Crastellier, at the distance of seven kilomètres to the east of Avranches." (See Plate 13.) In his Plate 1. it is remarkable that along the west coast of Normandy, the Emperor exhibits the then coast line *considerably farther west* than it is at present. Commencing at the Pointe de Cancalle, it runs about midway between the Minquiers and the present west coast, thence about midway between Jersey and the Norman coast, whence it runs out to Cape la Hagne, where it tapers to a point. It is called "Côté au temps de César." The present writer thinks it quite possible that the emperor is correct as to the locality of Sabinus's battle. The emperor's other views quoted, do not accord with the reasonings which have been submitted to the reader. His Majesty's volume was entered at the office of the Minister of the Interior so lately as May, 1866—See publisher's announcement, facing title. The present writer showed from Ptolemy, &c., several years before that date, that the land extended much farther westward than the line in the Emperor's map, and frequently insisted on the fact of these extensive sinkings in friendly conversations with M. Edouard le Héricher, who at length admitted that there might have been a little sinking. It is believed that this accomplished philologist took an active part in developing the scenes of Cæsar's achievements in Western Normandy for the Emperor's volume.

Translation of part of Cæsars' Commentaries on the Gallic War.

145. Book II., s. xxxiv.,—"At the same time he (Cæsar) was informed by Publius Crassus, whom he had sent with one legion to the Veneti, Unelli, Osismii, Curiosolitæ, Sesuvii, Aulerci, Rhedones, which are maritime states, and touch on the ocean, that all those states had been reduced into the authority and power of the Roman people.

Book III., s. vii.,—"* * when Cæsar thought Gaul subdued from all reasons; the Belgæ being overcome, the Germans being expelled, the Seduni being conquered in the Alps; a sudden war arose in Gaul. This was the cause of that war. P. Crassus, a young man, wintered with the seventh legion among the Andes* nearest the ocean sea. He sent off many præfects and tribunes of soldiers into the neighbouring states for the purpose of seeking corn, because there was a scarcity of corn in these places, in which number T. Terrasidius had been sent to the Eusubii; M. Trebius Gallus to the Curiosolitæ; Q. Velanius with T. Silius to the Veneti.

VIII. The authority of this state is by far the most extensive of all the maritime coast of those regions (regiones); because the Veneti have both very many ships, with which they have been accustomed to sail into Britain; and they excel the rest in the knowledge and use of nautical things; and in the great and open force of the sea, few harbours intervening which they alone hold, they have nearly all tributaries, who have been accustomed to use the same sea. The beginning of the detaining of Silius and Velanius was from them (the Veneti), because through them they thought they would recover their hostages whom they had given to Crassus. The neighbouring (peoples) induced by the authority of these (the Veneti), (as the designs of the Gauls are sudden and immediate) detain Trebius and Terrasidius from the same cause; and ambassadors being quickly sent, they conspire among themselves through their chiefs; that they would do nothing except by common design, and would bear the same issue of all fortune, and they entice the other states, that they would rather remain in that liberty, which they had received from (their) ancestors, than endure the slavery of the Romans. All the maritime coast being brought over quickly to their opinion, they send a general embassy to P. Crassus, "If he wishes to receive his (ambassadors), he may send back to them (their) hostages."

IX. Of which things Cæsar, being well assured by Crassus, orders long ships (ships of war) to be built meanwhile in the river Loire (Liger), which flows into the ocean, rowers to be prepared from the province, sailors to be obtained, because he was too far distant. These things being performed quickly, he hastened to the army as soon as he could through the time of the year. The Veneti and also the other states, the arrival of Cæsar being known, because they at once understood how great a crime they had committed of themselv s, that ambassadors—a name which had always been holy and inviolate among all nations—being detained by themselves and cast into chains, resolve to prepare war for the greatness of the danger, and chiefly those things which might belong to the use of ships; with greater hope on this account, because they trusted much in the nature of the place. They knew the foot roads were cut up by estuaries; that navigation was prevented by (our) ignorance of the places and the fewness of the harbours; they trusted that our armies could not delay long among themselves for want of corn. And though at last all things might happen contrary to their expectation, yet that they could effect much with ships; that the Romans had neither any force of ships, nor knew the shallows (vada), harbours, islands, of those places where they were about to carry on the war, and they saw clearly that navigation in an enclosed sea, and in a most immense and open ocean, were far different. These designs being adopted, they fortify the towns, they bring corn from the fields; they collect as many ships as they possibly can into Venetia, where it was evident that Cæsar was first about to carry on the war. They unite to themselves as allies, for that war, the Osismii, Lexovii, Nannetes, Ambiani, Morini, Diablintes, Menapii; they send for auxiliaries from Britain, which is opposite those regions (eas regiones.")

X. He states his difficulties and the many reasons he had for going to war, and resolves to distribute his army more widely.

XI. Therefore he sends his lieutenant Labienus, with the cavalry to the Treviri, who are nearest to the Rhine, and gives him certain directions as to the Belgæ, which are immaterial to the present purpose. He orders P. Crassus, with twelve legionary cohorts and a great number of cavalry, to set out into Aquitania, lest auxiliaries should be sent out of these nations into Gaul, and such great nations should be united. He sends Lient. Q. Titurius Sabinus with three legions to the Unelli, the Curiosolitæ, and the Lexovii, to take care that that band (of people) should be checked. He appoints D. Brutus, a young man, to the fleet and to the Gallic ships, which he had ordered to assemble from the Pictones and Santoni, and the other subdued countries: and he orders him to set out as soon as he could to the Veneti. Himself hastens thither with the infantry.

XII. The situations of the towns were commonly of this sort, that being placed in extreme tongues (*linguis*, or *lingulis*), and promontories, there was neither access for infantry when the tide rose, which happens always twice in the space of twenty-four hours, nor for ships, because the tide ebbing again the ships might be injured on the shallows. Thus, from each cause an assault of the towns was prevented; and if at any time, perhaps, overcome by the greatness of a work, the sea being shut out by a mound and by piers, and these being raised nearly as high as the walls of the town, they had begun to despair of their fortunes. By many ships, of which they had very great abundance, they carried away all their effects and betook themselves into the nearest towns; there they defended themselves again by the same advantages of the place. They did these things, therefore, more easily for a great part of summer, because our ships were detained by storms, and there was the greatest difficulty in sailing in an immense and open sea, with great tides, with few and almost no harbours."

XIII. He then describes the manner in which the ships of his enemies were built, armed, and rigged. The only advantage his fleet had was, that it was swifter, but his enemies' fleet was better suited to the place, being more strongly built, and able to withstand the violence of storms, so that when the sea began to rage they could trust themselves to it, and they could bear a storm more easily, "and could stop more safely on the shallows and being left by the tide, they feared not the great stones and ragged rocks; the chances of all which things were to be dreaded by our ships.

XIV. Many towns being stormed, when Cæsar understood that so much labour was taken in vain, neither could the flight of the enemies be checked, the towns being taken, nor could they be injured, he resolved to wait for his fleet. When it assembled and was first seen by the enemy, about three hundred of their best equipped ships having set out from port, ranged themselves opposite our (ships)." The Romans won the sea-fight chiefly by the stratagem of cutting the riggings of the Gallic ships with long scythes, which rendered them unmanageable. He proceeds:—"The rest of the contest depended on bravery, in which Cæsar's soldiers easily excelled; and the more so because the affair was carried on in the sight of Cæsar and all the army, so that no deed of greater bravery could be concealed, for all the hills and higher places, whence there was a near view to the sea, were held by the army."

XV. From this Section we gather that, the yards of the Gallic ships being thrown down, some of them were boarded by the Romans, which, when the Gauls saw, they sought safety by flight, and the ships drifting with the wind, so great a calm suddenly came on that they could not move, which was most convenient in respect of the business to be done, for the Romans pursued and stormed each ship, so that very few out of all the number could get to land before the night came on. The battle was fought from the fourth hour until sunset.

"XVI. By which battle the war of the Veneti and of the whole maritime coast was finished," and they surrendered to Cæsar who resolved to be revenged on them, and therefore he put all the senate to death and sold the rest.

"XVI. Whilst these things were carried on, Q. T Sabinus arrived in the borders of the Unelli with the forces he had received from Cæsar. Viridovix commanded them (the Unelli) and had the chief power over all those states which had revolted, from whom he had collected an army and great supplies. And in these few days the Aulerci, Eburovices and Lexovii; their senate being put to death because they were unwilling to be advisers of the war,* shut their gates and joined Viridovix," with a great number of abandoned men and robbers.

"XVIII. Sabinus kept himself in camp convenient for all purposes, while Viridovix encamped opposite him at a distance of two miles." Viridorix daily offered battle, but Sabinus affected to be afraid, and so came into contempt with the Gauls, and, in fact, he did not think he ought to accept battle against so many, Cæsar being absent, who ought to hold the chief command, unless a favourable opportunity offered.

XIX. Sabinus, by the stratagem of sending a Gaul to the enemy, who affected to be a deserter but really was a spy, induces the Gauls to attack him in his fortified camp.

XX. Sabinus's camp was high and gradually steep from the bottom, about a thousand paces. Up this steep the Gauls hastened at great speed, and by reason of the steepness and the great burdens of fascines which they carried, became exhausted and out of breath. Sabinus gives the signal, the Romans charge, and the Gauls immediately turn their backs and are killed in great numbers, and the cavalry having pursued the rest, very few escaped. "Thus at the same time Sabinus was informed of the naval battle, and Cæsar of the victory of Sabinus, and all the states surrendered themselves immediately to Titurius."

By the kindness of a friend I have a copy and translation of part of Lib. iv. of Procopius, *De Bello Gothico*. Procopius is so wild in his statements, and so much at fault in his geography, that it is of no use to quote him.

CHAPTER X.

ON THE SIGNIFICANCE OF SOME OF THE NAMES OF PLACES ON THE SAILING CHARTS OF THE CHANNEL ISLANDS.

146. It is common and notorious that places are often named from some peculiarity of form, position, colour, &c. The Bill of Portland, for example, is so called from its resemblance to the bill or beak of a bird, the northern part of the (so-called) Isle of Portland, forming the head of the bird, and Chesil Bank its neck. In case of any convulsion of nature destroying part of Portland, or of the Bank, it would be known that the head, or the neck, or the bill was missing, and thus *names* become *things*. Again, take Lizard Point, which is so called from the variety of colours of the Serpentine Rock, of which it is formed, resembling the colours of a Lizard, and the Serpentine Rock is also so called from its variety of colours resembling those of a serpent's back. In this case the latter name helps to an approximate date, for we know that the igneous rock called Serpentine, was only so called within the recent period since geology became a science. For it was called the Damnonium and Ocrinum Promontory in Ptolemy's time. Take another example. The Land's End is so called from being the extremity, or most western point, of England, but there was a period (probably in Ptolemy's time) when the land extended still farther towards the north-west; consequently the present Land's End can only have been so called since the second century. In this way every name on the Channel Islands' chart becomes a history, if we could only interpret it rightly. A few of these have been interpreted chiefly by eminent authorities, and have already been, or will now be, laid before the reader. I mention, as far as I know, what these authorities have done, taking their names in alphabetical order:—

(*a*). M. de Gerville, who studied the antiquities of Normandy, &c., forty years, and copied five or six thousand pages of MSS. and records. He did much in marine dredging.

(*b*). M. Edouard le Héricher, Regent de Rhetorique au College d'Avranches, author of a copious Anglo-Normande and other Glossaires, comprising more than 1,300 octavo pages, and evincing vast research from the very numerous quotations. And also author of "Avranchin Monumental et Historique," consisting of 750 octavo pages, and likewise affording internal evidence of great research.

(*c*). Mr. George Metivier, who has devoted great part of his life to philological studies, and whose accomplishments in that science are such that his countrymen and others are even now engaged in publishing an Anglo-Normande dictionary of his own, as a testimonial in his honour, with his portrait prefixed. I have done what I could to induce this gentleman, with whom I have had (to me) a most interesting correspondence, to pursue his inquiries into the origins of Channel Islands' topographical names. Dr. Hoskins, F.R.S., of Guernsey, is honorary secretary for promoting Mr. Metivier's testimonial.

(*d*). Professor Williams, of Lampeter College. He is Professor of Welsh there, and Britanny having been colonised by a Welsh speaking people, that language is one of the foundations of the Breton language.

Two of my friends who are also quoted, and myself, are amateurs. For my own part, I make no claim to be an expert in philological science, and therefore leave the various interpretations of words to the reader's own judgment.

147. With regard to the question whether any of the names on the charts are likely to have been given by caprice. It has been a custom from time immemorial for the whole agricultural populations of these islands, during certain periods, *which occur several times in every year*, and are called

* Valpy's edition says "people of Anjou, whom Pliny calls Andecavi or Andegavi," Vol. I., p. 114. It is on the Loire.

* Observe that the senate were not put to death by Cæsar *after the two victories* because they had advised the war, but were killed by their own people because they would not advise the war—*during the affair with the Veneti*. We find in s. 20, the spy telling the Gauls that Cæsar himself is pressed with great difficulties by the Veneti, proving that the two battles went on simultaneously.

"vraic"-ing seasons, to sally forth almost *en masse*, in carts or boats, as the case requires to cut and bring away seaweed for manure and fuel. They have names for far more rocks than are named on the charts, which have been, doubtless, handed down from generation to generation. Consequently any *original* name of a rock, or any appropriate name suggested by a special circumstance, may have been adopted from time to time by common consent. But it is submitted that any arbitrary name suggested merely by caprice, without any appropriateness, would scarcely have been adopted by the many, and transferred from generation to generation. Some of the following names have reference to the sinkings, others have not.

Names of Places on the Channel Islands Charts.

Annouet.—Mr. Metivier says (August 4, 1866), "Perhaps I may not have erred in presuming that '*Annouet*' was the Bas Breton *Annaguet*,' *i.e.*, anathematised, doomed to destruction. Hints in such cases are always more or less useful. When 'le Petit Flambeau de la Mer' was compiled, this reef was very extensive. This confirms your previsions." The present writer has not found Annouet on any of the charts, but future readers will find it.

Alderney.—Mr. Metivier says, speaking of Alderney, "As to Origny, there are several localities of that name in Normandy. In the oldest of our Celtic 'gebicten' (territories) Ireland, and in one of its romantic lakes there is an '*Arinia*' very near the point, a cape not unlike 'la Hague; Rjn (Rign) in Irish means a point." Hence the name Arinia for Alderney.

Casquet Rocks.—Again quoting Mr. Metivier: "Concerning *Casquet*, *i.e.*, *Casus rupes* in our Dictionnaire, I have not the slightest qualm." And again, "Casquet is one of the few topographical articles in our Dictionnaire. The termination 'quet' ought not to be noticed. Like *cascadt*, casquet comes from the Italian 'cascare,' to fall, Latin 'casicare,' a verb found in Plautus.

If so, I suggest that *casus*, derived from *cado*, signifies "to tumble or fall down headlong"—see Ainsworth's Latin Dictionary—and, therefore, a very appropriate name, if the ground and rocks sunk as I say they did.

Desormes Bank.—This bank is situated four or five miles north of the north-western angle of Jersey. Does it mean, as the name signifies, that the bank was formerly a "Bank of Elms?" We need not wonder at finding a modern French name attached to the place, because it probably first became sea as lately as 1356.

Grelets.—May not the large group of rocks so called, situate north-east of the Minquiers, derive their name from *Gréler* to hail, which also means to *spoil, destroy*, or *ruin*. Because when the ground sunk the sea would wash away the soil, and *ruin* the tract as land. In Admiral White's "Sailing Directions" the Grelets are mentioned as "extensive shelves of sand, shingle and rocks."

Grune.—In addition to what has already been said in Art. 26 on this word, it may be farther observed that the word "Grume," which only differs from "Grune" by the fraction of a letter—always signifies *some product of dry land*. For instance in Kelham's Dictionary of Norman words, we have "Grume," "Grun," *all sorts of grain*. And in Furetieres Universal Dictionary, "Grume" is said to signify *wood with the bark on*, in contradistinction to wood squared. In M. le Héricher's "Origines Germaniques," we read:—Grune, du Sax. *Gruna*, que Du Cange définit "locus paludosusus" (a marshy place) existe, avec *Groin*, dans des localités maritimes, telles que la plupart des îlots des Minquiers, entre la Bretagne et la Nord qui sont appelés Grunes," &c. The word Grune does not appear as far as I can discover, on any part of the French coasts except in the Channel Islands Seas, which is of itself a remarkable circumstance.—See M. le Héricher's lucid and copious explantion in his "Origines Germaniques."

Grune has in one instance been applied to a *lofty* marine rock, which is as great a mistake as it would be to call a *mountain* a *valley*. The name has probably only been applied to that particular rock within the recent period since Grune became an obsolete word, understood only by antiquaries. Mr. Metivier understands the word to signify 'a ridge of pebbles,' it is a matter of fact also, that the word is frequently applied to a low rock, for pebbles are scarce in these seas. And supposing (for argument's sake) that all the Grunes were once above high water, they would then have been covered with earth as nearly every yard of terra firma is, and they may have been as stated in Art. 26, "Grün" (German) *the Green*; or (as is said in the north of England) "Grund" for *ground*.

Hou.—This word has been treated of in Art. 42 preceding. In the excavations of British Tumuli in the Yorkshire Wolds, where many very ancient human bodies were interred and flint implements and several vases were at the same time found: these ancient sepulchres are thrice called "houe," as if they were *houses* of the dead. See *Times*, Oct. 24, 1866, p. 10. And three other barrows, are each called "houe" again, in the *Times* of Oct. 30, 1866, p. 10. And they are again called "houes" in the Summary as to the excavations, in the *Times* of Nov. 7.

Jersey.—This island has had several names, and has even been without a name at all, as we have seen. Gibbon gives 409 as the date when Britain and Armorica revolted from the Romans;* Lingard says 411.† At and probably somewhat before that date, it was called in the Roman itinerary, *Cæsarea*. In the year 550 it was called *Angia* or *Augie*; it was also called *Augia* as lately as 757 (Art. 55). During this space of two centuries it was also spoken of as "an island of the shore of Contances," as if it had no name: and it was called also *Brenciana*, vulgo *Brency*. Since when it has been called Gersui, Gersoi, and by Wace, the poet, in the twelfth century, Gersui and Gersi. Matthew Paris calls it Gersea, and a MS. chronicle in the library at Oxford, Gerzy (Arts. 52, 53). Can this name be derived from *Gercer* (French), to chap, crack, or flaw, *i.e.*, referring to its separation from Normandy? In Art. 59 it has been shown that *Brency*, a name of Jersey in 582, means a "remnant," which is very significant of its separation from the main land. We find in Le Héricher's valuable "Histoire et Glossaire," among his Origines Latines, as follows:—"Gerchier, Gercer, en vieux Français *Garcer*, inciser, scarifier, litteralement avoir un eschare, Eschara, d'où Scarificare, découper la peau." In his Origines Celtiques he gives "Jersey appelé *Gersich*, dans les Actes de Saint Helier." The terminal *ey* in Jersey is of course Celtic for *island*." At the end of Art. 59 it was said by the present writer, in consequence of something stated on the authority of Tupper's "History of Guernsey," that the latest sinking between Jersey and Normandy must have taken place since about the year 1000. For 1000 we ought to read 912, if Mr. Monrant, as quoted in Art. 160, is to be depended on, and probably he is. Mr. Métivier thinks Gercer or Garcer too modern to have been the origin of the name Jersey.

Minquiers.—This is a very extensive group of rocks south of Jersey, now almost entirely devoid of earth. Mr. Métivier says:—"As to the Minquers, or Minguys, it is not improbable that they were *Minich'is*, *Minihis*, sanctuaries like that of Great Tugdual, at Treguer, and in the islet of Herm, Eremus."

Professor Williams, of Lampeter, states in a letter to J. Gwyn Jeffreys, Esq., F.R.S., dated August 22, 1866, who kindly handed the letter to me, as follows:—

"Minquiers.—The large group of rocks south of Jersey is, I have no doubt, the same word as the Welsh *Meincian* (= meynkyay), which is plural of *mainc* (= maynk), which means anything raised, or elevated. The word as found in Gorseddfainc (v.), a throne; *i.e.*, a raised place used as a throne. Gorsedd mainc. It is applied to any kind of seat, especially of stone, and very commonly to a stone bench. In fact, 'bench' is akin to to it. It is applied as a proper name to a rock, rather a high one, on the roadside between this and Pontarddulais, Mainc Ivan Ddu. The plural meincian is to this day the name of a high group of limestone rocks near Llanelly, on the Carmarthen road."

On this Mr. Métivier remarks:—"Your Celtic friend's suggestion is valuable. The verb *meincio*, to fix benches, is Welsh. Nevertheless, the original term is Teutonic; and *banc*; Kymr, banc, table, bank; Gaelic, *beinc, being*, bench. Having travelled through history, it has always been my wish to confirm etymologies, not by conjecture, but with the help of document and testimony. Let me assure you, notwithstanding that, ere I decide on the signification of *Minquais, Minguis*, I shall reconsider what I thought of that group of rocks being *Minich'is* (*Minihis*), 'lieux de franchise;' Breton *Minic'hi*, Actes de Bretagne, Tome 3, par Dom Hyacinthe Morice, Paris 1746. There are a few such, witness the "Black Book of Landaff" in Wales. Wales is a shocking misnomer. The church of St. Tugdual, contemporary of St. Sampson, the ruins of which I have seen in the islet of Herm, might have been a *minihi*. Its surplice fees were great."

A young friend, who has greatly distinguished himself at Oxford University, says that "Minquiers" signifies "opening of the rocks," which would be a very appropriate name if correct, under the circumstances of the ground having sunk, for the earth upon and between the rocks would be washed away by the tides, and so leave *openings*. Another friend derives "quiers," the last syllable of Minquiers, from *quays*, or rather, he says, that the two words mean the same thing, the rocks being now like quays.

Ortac, a remarkable round-topped rock on the north-west of Alderney. Mr. Metivier remarks: "The etymon *Tac*, signum, standard, mast, a conspicuous object, seems to be connected with *or*, limit, border; not only Celtic, but old French, *ore*. We have a great many *Istacs*, *Etacs*.

Pommier.—About two miles N.E. of the Casquets, the *Pommier* banks appear on Capt. Richards's and other charts. If I was to say that *apple trees* once grew there, some ingenious gentleman would at once have an answer ready. Oh! no, he would say, the ship *Good Intent*, bound from Jersey to England with a cargo of cider apples, was wrecked there, and the name was in consequence of the quantities of apples which were seen floating about. He would forget for the moment, that *Pommier* means an apple tree, not an apple. I am led to this conclusion by the ingenious interpretations which some of my friends have found for the next name, *Roques aux Bois*. Mr. Métivier thinks Ponmmier an insular form of pommier, is a misnomer for Paulmier, a pilgrim.

* Vol. v., p. 346. † Vol. i., "Hist. of England," p. 80.

Roques-aux-Bois.—At $3\frac{1}{2}$ nautical miles in a direction nearly magnetic north-west from Grand Roque on the present westerly coast of Guernsey, and just within the 120ft. line of soundings at low water, mean springs (equinoctial tides fall three feet lower) there is a group of rocks, marked on the chart of Admiral White "Roque au Bois," and on Messrs. Sidney and Richards's chart, "Les Roques aux Bois," or rocks *at the wood.* And between those rocks and Grand Roque, and at two nautical miles from the latter is another rock called "Grune *du Bois*" on the former chart, and "Les Grunes de l'Ouest" on the latter chart, as if the two places had been *Woods*, or at all events low marshy land. A gentleman objects to this interpretation of "Bois," and supposes that when ships became, as it were, entangled among the groups of rocks now bearing the name of Bois, the sailors may have considered themselves according to the proverbial expression "in the woods," that is, in a difficulty how to get out from amongst the rocks. To this I answer: Considering that there are the actual trees of a forest or wood on the west of Guernsey, under the sand, *as far as extreme low water enables us to examine.* And considering that I saw at the farm-house, Fosse-aux-Fèves, near the west coast of Guernsey, many cart-loads of peat which had been dug near extreme low water, several feet below the sand, and abounding in tree roots; and, considering also the many proofs which have been given of sinkings of land in these parts, I think that the gentleman's objection is only an attempt (made, however, in perfect honesty and good faith), to explain away in the sense of getting rid of these remarkable names.

It has also been objected that the names may have been derived from *wreck*, or *drift wood*, having lodged there. To this I answer, that on Messrs. Sidney and Richards's chart, two of the Grunes de l'Ouest, are figured respectively as 10 and 6 feet above low water of mean Spring tides, and consequently such wreck can only have rested there at most for about two hours, because the rising tide would set it adrift again. I think such brief and rare events can never have had force sufficient to be the origin of the names of these rocks. For wreck wood coming *from distant parts over the Atlantic*, is, I have reason to believe, of rare occurrence on the west of Guernsey.

Sept. 5, 1861.—The present writer saw at the farm-house Fosse aux Fèves, near the west coast of Guernsey, many cart loads of gorban, or peat, which had been dug up near extreme low water. It was buried several feet below the sand. This peat abounded with tree roots; a few of the largest were as thick as a man's arm. This circumstancee appears to be significant that the peat may extend to an unknown distance below extreme low water. A crucial test would be to take numerous borings in the Channel Islands' Seas, where sinking is believed, for the reasons stated in these papers, to have taken place. This would probably cost not less than £200—an expense which the writer would not feel justified in incurring.

These are specimens of Channel Islands' sea names. They will serve to enable the reader to judge whether any light can be thrown on our subject by interpreting names. Have we any choice but to believe that there was a "Bois," or wood, at three and a-half miles out into the Atlantic, and to account for its having been so strangely situated in the best way we can? And is it not utterly incredible that these curious and very significant names should all be the results of mere accident? If the names we have been considering have really any significance at all, then it would follow that such comparatively modern words as Roque au Bois, Pommier, Ormes, &c., would mean that the events they seem to indicate must have occurred within a comparatively recent period. And, in fact, we have already had the year 1356 as the date of the most recent sinkings.

THE LABOUR MARKET IN THE UNITED STATES.

At the same moment that foreign competition is regarded with much evil foreboding in England, it is curious to observe similar apprehensions reproduced on the other side of the Atlantic. Mr. M'Culloch, the Secretary of the United States Treasury, in his annual report to Congress, draws a desponding picture of the American labour market, and the disastrous effect of high wages on manufacture and agriculture. A few years ago the American mercantile marine was in a singularly flourishing condition, and American shipbuilders supplied vessels not only to their countrymen but also to foreigners. Now many of the shipyards have been shut up, a great part of the business has been transferred to the British provinces, and there has been a falling-off in the shipping trade, which Mr. M'Culloch attributes not so much to the late war as to the decline of the shipyards, it being, he holds, "a well-established rule that the people who build ships navigate them." Such are the high prices of labour in the States that shipbuilders there cannot compete in cheapness with those of the British provinces, and that wages are especially excessive appears to be shown by the fact that "timber can be taken from Virginia to the British colonies, and thence to England, and can there be made into ships which can be sold at a profit; while the same kind of vessels can only be built in New England at a loss by the most skilful and economical builders." The erection of houses and manufactories is equally checked by the high rate of wages and prices of materials, and the same circumstances are said to be injuriously affecting agriculture and other interests.

While high prices are alleged to be the cause of the depressed state of American industry, they in turn are traced by Mr. M'Culloch to the evils of "a redundant currency and high taxes;" but apart from these, the prohibitive custom duties with which commerce and industry are shackled, form the main source from which this abnormal state of the labour market springs. Doubtless the perpetuation of the greenback and excessive taxation have their share in it; but in our opinion it is to the Morill tariff that most of the evils complained of are to be attributed. The system of prohibitive duties, surreptitiously introduced at the outbreak of the civil war in 1862, doubtless forms an abundant mine of wealth for a few hundred employers of labour in New England, but in no way tends to advance the interests of the community at large, and more especially the working classes. The apparent high rate of wages is a mere fiction, considering that in 1867 three paper dollars will hardly buy what, in 1860, was amply paid for with one silver dollar. Let the tariff of 1861 be repealed, and paper currency as well as the present high taxation will fall spontaneously; and the consequent equalisation of the conditions of the American labour market with that of Europe, and chiefly Great Britain, will tend to replace the welfare of the working classes of the Great Republic on that sound basis which has been undermined and neutralised by prohibitive protection.

Unfortunately, the present sectional Congress, so far from choosing the path prescribed by sound economical principles, seems bent upon excluding foreign manufactures from the American market altogether. The new tariff, just passed by the Senate, and which imposes a custom duty of cent per cent on an average, on the products of European industry, will tend to reduce the great Trans-Atlantic Republic to the level of China and Japan, so far, at least, as its commercial intercourse with other nations is concerned. However, we doubt not, the sound sense of the American people will eventually foil the aspirations of those pursuing but their own selfish objects, with utter disregard of the true spirit of the nineteenth century.

WAGES IN THE UNITED STATES.

From a return issued by the U.S. Bureau of Statistics, of the average wages paid to working people in different parts of the country, during December last, we extract the following data respecting the engineering, building, and manufacturing trades. The four places quoted as specimens are Hartford, Connecticut; Tunkhannock (a place in the black country of Pennsylvania); Tiffin (an agricultural town in Ohio), and Cairo, Ill., situated at the confluence of the Ohio and Mississippi rivers. The equivalent for the greenback dollar in British coin is about 3s. 2d., 100dols. in gold being, on a three months' average, equal to 135dols. in currency.

Trade.	Hartford. dols. c.	Tunk-hannock. dols. c.	Tiffin. dols. c.	Cairo. dols. c.
Bricklayers, per day	3 25	3 00	2 75	6 50
Brickmakers, per day	2 25	2 50	3 00	3 25
Blacksmiths, per day	2 00	2 75	2 25	3 00
Carpenters, per day	2 75	3 00	3 00	3 50
Cabinetmakers, per day	2 75	2 75	2 50	3 00
Factory hands, per week	7 50	... ...	... ...	14 00
Ironfounders, per day	3 00	2 50	1 25	3 00
Machinists, per day	3 00	3 50	3 50	3 50
Moulders, per day	... ...	2 50	2 75	3 25
Painters, per day	2 75	3 00	2 50	3 25
Plumbers, per day	2 50	5 00	... ...	2 75
Compositors, per 1000 ems	0 35	... ...	0 20	0 50
Railroad hands, per month	40 00	45 00	30 00	60 00
Stonecutters, per day	3 00	3 50	3 00	4 75

PILE DRIVING.

By Chas. H. Haswell, Civil and Marine Eng., N.Y.

The effect of the blow of a ram, or monkey, of a pile driver, is as the square of its velocity, but the impact is not to be estimated directly by

this rule, as the degree and extent of the yielding of the pile materially affects it. The rule, therefore, is of value in application only as a means of comparison.

By my experiments in 1852, to determine the dynamical effect of a falling body, it appeared that whilst the effect was directly as the velocity, it was far greater than that usually estimated by the formula $\sqrt{s\,2\,g}$, which, for a weight of 1lb. falling 2ft., would be 11·34, giving a momentum of 11·34ft. lbs., whereas by the effect shown by the following record of actual observation, it would be 4·426 $v\,w$ = 50lbs.

Results of experiments made to determine the dynamical effect of bodies falling freely, 1852.

Weight of falling body, avoirdupois	Space fallen through.	Velocity acquired at end of fall, per second.	Effect as indicated by instrument
lbs.	feet.	feet.	lbs.
·5	·5	5·67	12·5
·5	1·	8·02	17·75
·5	2·	11·34	25·
·5	3·	13·89	31·
·5	4·	16·04	36·
·5	5·	17·93	40·
1·	·5	5·67	25·
1·	1·	8·02	35·5
1·	2·	11·34	50·
1·5	·5	5·67	37·
1·5	1·	8·02	53·
2·	·5	5·67	50·
2·	1·	8·02	71·5

Piles are distinguished according to their position and purpose: thus gauge piles are driven to define the limit of the ground to be enclosed, or as guides to the permanent piling.

Sheet or close piles are driven between the gauge piles to form a continuous enclosure of the work.

The weight which is required of each pile to sustain, should be computed as if it stood unsupported by any surrounding earth.

When the length of an oak pile does not exceed sixteen times its diameter, it may be loaded permanently with a weight of 450lbs. per square inch of its sectional area.

A heavy ram and a low fall is the most effective condition of operation of a pile driver, provided the height is such that the force of the blow will not be expended in merely overcoming the inertia of the pile, and, at the same time, not form such a height as to generate a velocity which will be expended in crushing the fibres of the head of the pile.

The refusal of a pile intended to support a weight of $13\frac{1}{2}$ tons can be safely taken at ten blows of a ram of 1,350lbs., falling 12ft., and depressing the pile four-fifths of an inch at each stroke.

Pneumatic piles.—A hollow pile of cast iron, $2\frac{1}{2}$ft. in diameter, was depressed into the Goodwin sands 33ft. 7in. in $5\frac{1}{2}$ hours.

Nasmyth's steam pile hammer has driven a pile 14in. square, and 18ft. in length, 15ft. into a coarse ground, imbedded in a strong clay, in 17 seconds, with twenty blows of the hammer, or monkey, making 70 strokes per minute.

By the extended observations of Brevet Major John Sanders, U.S. Engineers, he deduced the following rule whereby to estimate the weight that can be safely borne upon a pile: "As many times the weight of the ram, as the distance which the pile is sunk, the last blow is contained in the distance which the ram falls in making the blow, divided by 8," which, when reduced to a formula, becomes

$$\frac{(\text{R} + h \div d)}{8} = \text{w},$$

R representing the weight of the ram in pounds, h the height of the fall, and d the distance the pile is depressed by the blow, both in feet.

Here, then, is obtained a formula whereby to compute the limit of operation of a driver, which is essentially all that is required.

Illustration.—A ram, weighing 3,500lbs., falling $3\frac{1}{2}$ft., depressed a pile 4·2ins. Then,

$$\frac{3500 \times (42 \div 4{\cdot}2)}{8} = \frac{35000}{8} = 4375 \text{ lbs.},$$

the weight which the pile would bear with safety.

By the ordinary formula $\sqrt{v\,2\,g}$ w, 15 × 3500 = 52,750lbs., the computed force; hence, assuming the rule of Major Sanders as a guide $\frac{4375}{52{,}750} = {\cdot}0814$, which may be taken as the co-efficient whereby to reduce the momentum of a ram to the weight the pile can bear with safety.

Messrs. M. Scott and J. Robertson submitted to the Institution of Mechanical Engineers, London, 1857, a paper on the "Theory of Pile Driving," of which the following are the essential points, when briefly given, viz.:

The object of the investigation of pile driving is not to determine to a fraction of an inch the distance a pile may be driven, and especially so, as the resistance offered by the earth, which is the most important element cannot be correctly ascertained, but the object is to elicit the simple and general truths upon which the system depends.

Dr. Whewell deduced:—

1. A slight increase in the hardness of the pile, or in the weight of the ram, will considerably increase the distance the pile may be driven.

2. The resistance being great, the lighter the pile the faster it may be driven.

3. The distance driven varies as the cube of the weight of the ram.

Although these deductions cannot be depended upon as exact under all circumstances, they give a tolerably correct indication, and are in accordance with those which may be arrived at by general reasoning. The complication in the original expressions arises from taking into consideration in the general question the weight and inertia of the pile. The weight of the pile bears so small a proportion to the resistance of the earth, that it may be neglected; for a pile 25ft. in length and 1ft. square weighs about one-half a ton, and if the fall of a ram weighing one ton is 10ft., and the distance driven by the blow is two inches, then the resistance of the earth will be to the weight of the ram as 120ins. to 2ins.; that is, it will be 60 tons, of which one-half a ton is the $\frac{1}{120}$ part, and may, therefore, be neglected.

To compute the Space through which a Pile is driven.

$\frac{\text{R}\,h}{\text{C}} = s$, C representing the resistance of the earth. Hence, by inversion,

To compute the Co-efficient of the Resistance of the Earth.

$$\frac{\text{R}\,h}{s} = \text{C}.$$

Weissbach gives the following formula:—The resistance of the bed of earth being constant, the mechanical effect expended in the penetration of the pile will be:—

$$\frac{\text{R}^2\,h}{\text{P} + \text{R}\,s} = \text{W}.$$

Taking the elements of the preceding case, with the addition of the weight of the pile at 1,500lbs., the result would be:—

$$\frac{3500^2 \times 3{\cdot}5}{1500 + 3500 \times (4{\cdot}2 \div 12)} = \frac{42{,}875{,}000}{1750} = 24{,}500 \text{ lbs.}$$

The range for security is given from $\frac{1}{10}$ to $\frac{1}{100}$. Assuming, then, the rule of Major Sanders as correct, the deduction from this rule would be $\frac{2}{11}$.

RAILWAY BILLS IN PARLIAMENT.

On January the 18th, Messrs. Frere and Palgrave, the examiners appointed to inquire into the standing order requirements of the House of Commons, commenced their sittings. Up to the present they have passed the following railway and other bills:—Forth and Clyde Junction and Caledonian; Skipton and Wharfdale; Wolverhampton and Walsall; Brecon and Merthyr Tydvil Junction; West Cork; Crystal Palace and East London High Level; Petersfield and Bishops' Waltham; Blythe and Tyne; Forth and Clyde Junction and Caledonian and Skipton and Wharfdale Railways; Greenwich and South Eastern Docks; Caledonian and Forth Navigation (amalgamation); Caledonian (Forfarshire works, etc.); Norwich and Spalding; Denbigh, Ruthin, and Corwen; Mold and Denbigh Junction (amalgamation); Midland (additional powers); North London Thames Embankment (north) approaches; Midland and Glasgow and South Western Railway Companies; South Wales and Great Western direct, the Carnarvon and Llamberis and Great Western (various powers); the London and North Western (new works, etc.); the Rhymney (new lines, etc.); Thames Navigation; Maidstone and Ashford; South Eastern; Sevenoaks, Maidstone, and Tunbridge; London and North Western and Midland (Huddersfield and Halifax Railway); Devon and Somerset (deviation); Great North of Scotland (further powers); Metropolitan; Dundalk and Greenore; Waterloo and Whitehall (extension of time, &c); South Sea; Bristol, port and pier; Manchester, Sheffield, and Lincolnshire (additional powers); Kilkenny Junction (abandonment of Kilpurcall Branch); London, Brighton, and South Coast; Belfast Central; Hoylake (Chester extension); London and South Western (further powers); Ilfracombe; Bedford and Northampton; Wensum Valley; North Western and Charing Cross; Ross and Monmouth; Newport; London and North Western (lines at Burton-on-Trent); London and

North Western (Ashby and Nuneaton lines); London and North Western and Lancashire and Yorkshire Companies; Wilts and Gloucestershire; Swansea Vale; Bradford Canal Navigation and Leeds and Liverpool Canal Company; Tendring Hundred; Hull Docks; Jule and Shipley; Lancashire and Yorkshire (North Lancashire loop line); Carnarvonshire (deviations, &c); Newry and Greenore; London, Chatham, and Dover; Barnoldswick; Devon and Cornwall; Swansea Vale (lease); Neath and Brecon (additional powers); North Metropolitan; Easton and Church Hope; Central Cornwall railway (No. 2); Furness (additional powers) Bill; Waterford and Wexford railway; Rosslare Harbour Bill; Bradford Canal; North Metropolitan; Easton and Church Hope railway; Great Eastern railway (steamboats); Central Cornwall railway (No. 1) Central Cornwall (No. 2); Great Eastern Railway—Cheshire line; Sunderland Extension and Improvement; Halifax and Ovenden junction; East Gloucestershire; Car, marthen and Cardigan; Midland (Derby Gas Bill); Bodmin, Broxburn-Caledonian (Deviation branches, etc.); Bristol and Exeter (further powers); Bristol and Exeter (Exe Valley railway); Devon and Somerset; Bristol and Exeter; Newry and Armagh; Atlantic Telegraph; North Staffordshire; Cambrian (extension of time, etc.); Tewksbury and Malvern; North British (Carlisle deviation, etc.); Northumberland Central; Waterloo and Whitehall (abandonment, etc.); Rhondda Valley and Hirwain Junction; Ryde Pier and Ryde station (railways); Atbenry and Ennis Junction; Dublin Rathmines, etc., railway; Midland and Eastern, Norwich and Spalding, and Stamford and Essendine; West Riding and Grimsby; Drayton Junction; Milford Haven dock and railway; Surrey and Sussex Junction railway; Hayling railways; Navan and Kingscourt railway (deviations); Cambrian railway (voting at meetings, etc.); Garstang and Knot End railway.

ROYAL NAVAL ENGINEERS.

We have, upon several previous occasions, adverted in these pages to the disabilities under which that most useful class of public servants—the engineer officers of the Royal Navy—are labouring; and we now gladly find room for the following statement, which has just reached us, and which we give in its entirety:—

In presenting the following statement of the disabilities of which the engineer officers of the Royal Navy have to complain, they desire, in the first place, to express their grateful sense of the consideration which the statement issued by them on the 1st January, 1866, received, and which resulted in the grant of ordinary pensions to the widows of "engineers," and increase of full pay to the "inspectors of machinery afloat."

But while fully appreciating these benefits, which affect only the higher and lower grades of the profession, they feel that the position of those officers who hold the intermediate place between those two grades, is much in need of improvement.

They therefore venture to submit that the "chief engineers" of the Royal Navy should be permitted to reckon for increase of full and half pay the *whole* of the service which had been rendered previous to attaining that rank, instead of *only four years*, as is the case at present.

The reasons upon which this request is founded, were detailed in the document above referred to, but it will be necessary to recapitulate them.

An engineer officer entering the navy must be of full age, and possessed of the necessary attainments, educational as well as practical, to qualify him for immediately commencing a course of arduous and responsible service, extending over a period of from twelve to fifteen years (the average is now above thirteen years, and is rapidly increasing) before he attains the rank of chief engineer; and in many instances, a considerable portion of that time is served in the capacity of senior engineer of a small vessel, where, being in charge of the machinery, the officer is called upon to perform the duties and incur the responsibilities attaching to the position of chief engineer. It is therefore considered a very great hardship that so large a portion of time during which valuable service has been rendered should be lost. It will also be found that the average age at which an engineer officer arrives at ward room rank is much higher than is the case with officers belonging to any of the collateral branches of the navy, and this disproportion will become greater in the future, unless means be devised to insure a more satisfactory flow of promotion; as during the past year the promotions to the rank of chief engineer have not reached one per cent upon the number of juniors, and it thus appears certain that the long period now required to attain the rank of chief engineer will hereafter be much extended. It should also be borne in mind, that in consequence of not having been promoted at an earlier period of life, the majority of the present chief engineers will be unable, under present regulations, to attain the highest rate of full pay allotted to that rank sufficiently early to realize any other advantage than the increased rate of half pay or retirement contingent upon its attainment; and that a large number will fall short even of that benefit, by being unable to render the amount of service required, viz. twenty-one years, in the rank of chief engineer; consequently that rate of full pay, instead of being enjoyed for a moderate period as a reward for long and meritorious services, is practically unattainable, except by a limited few, who, from some unusually fortunate combination of circumstances, have reached the rank of chief engineer at an age considerably below the average. The engineer officers of the navy therefore trust that their request to be permitted to reckon their whole term of service for increase of full and half pay on attaining the rank of chief engineer instead of the small portion now allowed, will meet with the favourable consideration of the admiralty.

The next request preferred in the statement of the 1st of January, 1866, was, that a proportionate increase of full and half pay should be allowed annually, instead of at intervals of five years, as at present. This request is submitted on account of the very great hardship experienced by those officers, who, from illness or other cause, may be removed, temporarily or permanently, from active service, at a time when a large portion of the required term of five years has been served, and who, for want of the remaining portion of the term (possibly only a few weeks or even days), are deprived, by the present system, of a very large fraction of their income, in some cases as much as one-fourth being thus lost to the officer. This would be remedied if a proportionate part of the increase now granted at intervals of five years were allowed for each year's service, as it would then be impossible for an officer to lose more than one year's time; and while the concession of this request would confer a very great boon upon the officers interested, the difference to the estimates would be so trifling, when spread over the five years, as to be scarcely worth notice. The engineers are led to hope that this request will be favourably received, from the fact that the old system of requiring five years' service to be rendered for each increase of full and half pay has been broken through in the case of other classes of officers; and although they have ventured to submit that increase of pay should follow upon the completion of each year's service, yet the abbreviation of the present term in any degree would necessarily mitigate the evil complained of.

The full pay of the inspectors of machinery has recently been increased, and while the engineers of the Navy gratefully acknowledge the boon thus conferred, they feel bound respectfully to express their opinion that the pay of the inspectors of machinery is still incommensurate with the very great responsibility attaching to their position; and they therefore beg to submit that the pay of inspectors of machinery should increase with length of service, as is the case with nearly all other officers. As regards the half pay and retirement of these officers, an anomaly exists so striking that the engineer officers trust it will be only necessary to direct attention to it to insure its removal. The inspectors of machinery are the only officers in the navy who have no distinct rate of half pay allotted to their rank, and in the event of one of these officers being placed upon the retired list, he would, under present regulations, receive no greater amount of retiring allowance than if he had continued serving as a chief engineer, his services in the superior rank of inspector of machinery being entirely ignored.

The engineer officers of the navy, beg to direct especial attention to the stagnation now existing in the promotion to the rank of chief engineer, only five officers having been promoted to that rank during the year 1866. As the names of the engineers are excluded from the official navy list—a circumstance which, although possibly only an accidental or unintentional omission, is felt to be a very invidious distinction, the names of all other officers holding the same relative rank being inserted in that publication—the correct number of officers of that rank cannot be authoritatively quoted, but as they may be safely estimated to exceed 400, it is manifest that the prospect of the majority is a very dismal one. They trust that some means will be devised whereby a more satisfactory flow of promotion will be insured.

They are also desirous of calling attention to the suggestions made in the evidence given before the select committee of the House of Commons on navy promotion and retirement in 1863 (vide questions 3411—2) relative to the appointment of an inspector of machinery as part of the staff of each flag officer; which if adopted, would open a field for promotion, and confer rewards upon talented and deserving officers; and would, at the same time, relieve the chief engineers of the flag ships, by whom the duty is at present performed, from a heavy and unremunerated responsibility.

The very great extension which has recently taken place in the application of machinery of a delicate and complicated nature to various purposes, other than propulsion, on board ships of war, has very materially increased the duties and responsibilities of the engineers of the Navy, upon whom the general supervision and maintenance in a due state of efficiency of such machinery devolves, and by whom such repairs as may be required at sea must necessarily be performed, thus rendering the services of scientific, experienced, and skilful engineers of continually increasing value to the country. The engineer officers of the Navy therefore trust that the requests herein set forth, and which they believe to be based upon principles of moderation and justice, will meet with favourable attention from the authorities; and that the disabilities of which they now complain, will shortly be removed by the adoption of the suggestions which they have respectfully submitted, or by such other means as, in the wisdom of the Admiralty, may appear to be proper.

6th February, 1867.

ROYAL GEOGRAPHICAL SOCIETY.

ON THE GEOGRAPHY AND CLIMATE OF INDIA, WITH REFERENCE TO THE BEST SITE FOR A CAPITAL.

By the Hon. George Campbell.

The author, having assigned various reasons, political and otherwise, for changing the capital of India, discussed in his paper the relative advantages of various districts with reference to the best site for the seat of Government. In pursuing his inquiries he himself visited all the British Provinces in India. The choice was limited, he remarked, by the necessary conditions of centrality, proximity to a seaport on the side of India nearest to England, suitability of climate both to Europeans and natives, roominess for the expansion of the settlement, and proximity to a great European and civilised native community engaged in practical business. After passing in review various healthy districts in the Punjab, along the southern slopes of the Himalaya, in the Neilgherries, and along the Western Ghauts, giving an account of the elevation, position, and climate of each district, the author finally decided on the town of Nassik, on the Deccan plateau, 116 miles to the north-east of Bombay, and within five miles of the line of the Great Indian Peninsular Railway. It is situated on the banks of the Upper Goodavery, and in a fertile district enjoying a salubrious climate, not too cool for a native population. He considered Nassik superior in many respects to Poonah, which also presented similar advantages, being on the same plateau, and 119 miles to the south-east of Bombay.

Mr. W. J. Hamilton (chairman of the Great Indian Peninsular Railway Company), believed the district of Nassik would be found too deficient in water to be suitable as the site of a large city. The greatest difficulty which the railway company had to contend with, in the construction of their line from the top of the Ghauts into the valley of the Taptec, was the want of water for the engines.

Sir Robert Montgomery said he could not agree with the conclusions Mr. Campbell had come to with regard to the necessity of changing the capital from Calcutta. It was not necessary that a capital should be central. None of the great European capitals were central; nor was Washington central. Moreover, at Calcutta the Governor-General had other interests to look after, besides the government of Hindostan Proper. The affairs of Pegu, Penang, and even of China, were brought under his notice; therefore, with reference to China and Hindostan combined, Calcutta did occupy a central position. The removal of the seat of Government from Calcutta would result in loss of prestige; and now that the country was being supplied with railways and telegraphs, Calcutta would be placed in rapid and direct communication with England, and the question of distance became of less consequence than it was formerly.

Sir Charles Trevelyan said the only substantial reasons which could be assigned for removing the capital from Calcutta were political. The political system of local governments, and the part of the Supreme Government was to superintend and revise the local administrations, and to take charge of the departments common to all. On this account it was evident that the Supreme Government ought not to be at the seat of any of the local governments. The climate of Calcutta, Madras, and Bombay, and their position on the extremities of the empire, were objections to either of them being the seat of the Supreme Government. The conclusion was therefore inevitable that the capital should be central, healthy, and so situated as to be in easy and direct communication with all the local governments. He was not prepared to say that Nassik should be the site selected, nor did he think the question had yet arrived at that stage that it was necessary to fix upon any particular spot; but it should be some place in the centre of the continent on the line of the Great Indian Peninsular Railway; and if he were obliged to indicate the proper position, he should say between Nagpore and Mhow, or Mhow itself, which was very healthy and very central.

Sir Erskine Parry said the objections to Calcutta were very obvious. It was very remote, and the climate was bad for Europeans. He thought Mr. Campbell had been fortunate in the selection of the site he had pointed out. It was central, near a large seaport, and possessed a suitable climate. The only objection was that the supply of water would be inadequate for a large population, and it was well known that all articles of food are fifty per cent. dearer in that part of India than in the plains of Bengal.

Sir Henry Rawlinson stated that Bombay was now in process of being made the postal port of India. A Committee of the House of Commons, last year, had made a recommendation to that effect, and arrangements were actually in the course of completion. This made it almost a matter of necessity that the seat of the Central Government should be within a convenient distance of Bombay. But he was not prepared to abandon a well-known locality like Poonah for Nassik. If we are to have the capital of India in the Deccan, he should vote in favour of Poonah.

ELECTRIC TELEGRAPHS IN AUSTRALIA.

The report of E. C. Cracknell, Superintendent of Electric Telegraphs, for 1866, has just been laid before the Legislature of New South Wales. The following facts and figures, extracted from this well-written document, are of a more general interest.

Mileage.

The aggregate mileage of telegraph lines open in the four most important colonies of the mainland of Australia, on January 1st, 1866, was as follows, viz.:—

New South Wales ...	3,177	miles of wire, with		57	stations.
Victoria	3,109	,,	,,	69	,,
South Australia	1,182	,,	,,	42	,,
Queensland...........	1,131½	,,	,,	24	,,
Total	8,599½	,,	,,	192	,,

Financial Condition.

New South Wales.

Receipts	£31,362	5	5
Expenditure	21,310	11	9
Nett profit	10,051	13	8

Number of messages transmitted, 138,785.

Victoria.

Receipts	£35,767	17	4
Of which on H.M. service	11,546	19	3

Expenditure not returned.

Number of messages transmitted, 279,791.

South Australia.

Receipts	£10,791	2	10
Expenditure	9,416	11	10
Nett profit	1,374	11	0

Number of messages transmitted, 106,874.

Queensland.

Receipts	£12,382	0	0
Expenditure	12,226	0	0
Nett profit	156	0	0

Number of messages not returned.

The steady progress of the telegraph lines in the Colony of New South Wales becomes apparent from the following table:—

Progressive Details of Electric Telegraphs in New South Wales, from their Commencement, up to 31st December, 1865.

Years.	Cost of Lines. £ s. d.	Miles of Line.	Second Wire.	Total Length of Wire.	Number of Stations.	Number of Messages transmitted.	Net Revenue after paying Working Expenses. £ s. d.	Working Expenses in Excess of Revenue. £ s. d.
1858.........	17,253 12 11	372	...	372	11	9,141	....	154 18 9
1859.........	23,816 19 9	470	...	470	12	36,867	3,179 10 1	....
1860.........	48,454 2 2	646	527	1,173	23	53,981	2,728 0 10	....
1861.........	60,615 13 3	1,217	...	1,744	36	74,224	3,626 13 5	....
1862.........	116,234 11 7	1,457	...	1,984	47	104,660	8,733 2 3	....
1863.........	118,940 12 2	2,227	...	2,754	48	124,638	9,149 16 3	....
1864.........	132,025 18 3	2,374	...	2,901	52	130,500	7,593 6 9	....
1865.........	145,350 5 4	2,584	...	3,177	55	138,785	10,051 13 8	....

INSTITUTION OF CIVIL ENGINEERS.

At the monthly ballot on Tuesday evening, the 5th ult., Mr. Charles Hutton Gregory, vice-president, in the chair, the following candidates were ballotted for, and declared to be duly elected, including fifteen members, viz.:—Mr. Charles Bernard Baker, resident engineer on the Midland Railway Extension to London; Mr. Henry Baylis, borough engineer, and engineer to the Corporation Waterworks, Bolton, Lancashire; Mr. Michael Beazeley, assistant engineer on the Wolf Rock Lighthouse Works, Cornwall; Mr. James Bolland, Westminster; Mr. William Crozier, engineer to the county of Durham; Mr. James Deas, engineer of the western division of the North British Railway, Glasgow; Mr. Thomas Fenwick, Leeds; Mr. Daniel Gallagher Grose, Dublin; Mr. John William Grover, Westminster; Mr. Henry Law, late of Rio de Janeiro; Mr. William Lawford, chief assistant engineer to the Great Western Railway Company; Mr. George Owen, engineer of the Cambrian Railways; Mr. Charles Robins, Westminster; Mr. Francis Stevenson, principal assistant engineer of the London and North Western Railway; and Mr. Thomas Jefferson Thompson, principal resident engineer and locomotive superintendent of the Bahia and San Francisco; and seventeen associates, viz.:—Mr. William Henry Ashwell, Midland Railway Extension Works, Camden-town; Mr. Joseph Parkin Colbron, Surveyor to the West Hove District Commissioners, Brighton; Vice-Admiral George Elliot, Warwick-square; Mr. William Francis, Westminster; Mr. John Clark Hawkshaw, B.A., New Dock Works, Hull; Mr. Follett Charles Hennett, Ironworks, Bridgewater; Mr. Harry Pasley Higginson, Madras Irrigation and Canal Company; Mr. John Howkins, jun., Barrow Docks, Barrow in Furness; Mr. George Albert Hutchins, Carmarthen; Mr. Charles Edward Mackintosh, Railway Foundry, New Cross; Mr. John James Myres, jun., Preston, Lancashire; Mr. Charles O'Neil, resident road and bridge engineer, Wellington, New Zealand; Captain Robert Robertson, R.N., Board of Trade; Mr. Alexander Clunes Sherriff, M.P., Westminster; Mr. Henry Thomas Tanner, Newbury; Mr. Charles Brown Trollope, Westminster; and Mr. William Cawthorne Unwin, B.Sc., Homerton College.

ABSRACT OF DESCRIPTION OF THE CLIFTON SUSPENSION BRIDGE.

By Mr. W. H. Barlow, M. Inst. C.E., F.R.S.

The construction of this bridge was commenced more than twenty-five years ago, but remained in abeyance for a considerable length of time, owing to a concurrence of unforeseen obstacles. The abutments and the piers, ready to receive the saddles for supporting the chains, were completed, from the designs of the late Mr. Brunel, in the year 1843, when the works were suspended from insufficiency of funds. In 1860 a new company was formed, and arrangements were entered into for the purchase of the land and piers at Clifton, and of the chains from the Hungerford Suspension Bridge, then about to be replaced by a girder bridge, to carry the Charing Cross Railway.

In the Clifton bridge as executed, there are three chains on each side, supporting longitudinal stiffening girders of wrought iron, with open-work cross girders, the hand railing of the bridge being made also to form longitudinal stiffening girders, with open-work sides. The principal dimensions are: span 702ft. 3in., distance from centre to centre of chains 20ft., width of bridge, including roadway and footways, 31ft., versed sine of curve of chains 70ft., and height of roadway above high water 248ft. The chains are carried upon the piers by wrought iron saddles, placed upon roller frames of cast iron, the rollers being made of cast steel. The beds of the roller frames are at an inclination of 1 in 20, rising towards the river. At a distance of 196ft. from the centres of the piers there are land saddles similar in construction to the saddles upon the piers, except that they have no roller frames, but are bedded upon brickwork in cement set upon the solid rock. The distance from the land saddles to the anchorage is 60ft., with an average inclination of 45°; and in this distance the three chains gradually diverge, until they are 5ft. apart; here they were inserted through castings forming separate anchorage plates for each chain. The three chains are in such a relative position to each other as to produce an equal horizontal distance of nearly 8ft. from the centres of the suspension rods throughout the bridge. The suspension rods transmit their strain to the chains only at the joints; so that the links of the chain have no other strain upon them than that due to the direct tensile strain in the direction of their length. The duty of maintaining an equal action upon all three chains in supporting the roadway is performed by the strength and stiffness of the longitudinal girders. All the links were tested to a strain of 10 tons per square inch.

The arrangements for the erection of the chains comprised a temporary suspended staging, constructed of eight iron wire ropes, each capable of bearing 35 tons. Six of these ropes served to support a timber platform, and two were at a height of 3ft. 6in. above, to form a hand railing on each side. The upper ropes were attached to those below, so as to act in conjunction with them in sustaining any weight upon the staging. Another rope was fixed above, for the purpose of carrying two light travelling frames, suspended on wheels, which were moved as required by light ropes, and by means of which links were taken from the piers to the men engaged in erecting the chains. The work was commenced at the anchorage plates at each end simultaneously, the lower chain being put in first. At the anchorage plates the whole of the links, twelve in number, were inserted; then eleven, ten, nine, and so on, until the chain was diminished to one link; after which it was continued at one link and two links alternately from the piers, until it met in the middle of the centre opening. The wire-rope staging was designed to carry the weight of the centre portions of the chain, formed of one link and two links alternately, with the men and tools required to erect it. The calculated breaking weight of the staging was 224 tons, evenly distributed, and the weight it had to carry was 40 tons. The suspended platform was kept below the intended level of the chains, and the links were supported upon it by packing pieces which could be raised or lowered. When the links of the chain were united in the middle, the packing pieces were lowered until the chain took its own bearing and thus relieved the staging from the action of its weight. At this stage of the proceedings, the chain was adjusted for length, by means of keys arranged for that purpose in the first links from the pier saddles. The next operation was that of adding links on each side of the centre links, which was accomplished by an ingenious and simple apparatus, with such rapidity, that on some days more than one hundred links were added. The chains on the Bristol or eastern side having been completed, the staging was removed to the other side, and the remaining three chains were put up in a similar manner. When the chains were erected, and the suspension links fixed, the suspension rods and cross girders were attached, by means of a moveable crane, upon a long base frame, weighing upwards of 5 tons, and travelling upon a temporary railway. This crane was so contrived and balanced, that it could carry a cross girder, with an equivalent length of the longitudinal girders, a considerable distance in advance of the wheels upon which it travelled. Thus, when placed upon the abutment, it held the first cross girder in its intended position, until the men attached the first pair of suspension rods to it and to the chains. Planking was then laid from the abutment to the cross girder, and the railway was lengthened. The travelling crane next took up the second cross girder, and advanced with that to its position, and held it in like manner until it was attached to the chain. The planking and roadway were again lengthened, and the third cross girder fixed, and so on from both ends of the bridge, until the roadway met in the middle. The remaining operations of connecting the longitudinal girders, adjusting the several parts of the work, and laying the roadway, were then proceeded with.

The sectional area of the chains at the pier is 481 square inches, and in the centre of the span 440 square inches. The weight of the chains between the piers is 544 tons, and that of the suspension rods, longitudinal and transverse girders, cross-bracing, hand-railing, roadway, &c., about 440 tons. The strain at the centre due to the chains is 680 tons, that due to the weight of the platform, &c, 597 tons, and that produced by a maximum moving load of 70lbs. per square foot, 817 tons, or together 2,094 tons, equal to 4·76 tons per square inch of the sectional area of the chains at the centre of the span. The suspension rods are each rather more than 2in. in section. The greatest weight that can come upon a pair of rods, including their maximum load, is about 13 tons, which will produce a strain of $4\frac{1}{4}$ tons per square inch. The anchorage plates and the bearing plates of the saddles are so arranged that the maximum pressure upon the brickwork cannot in any case exceed 10 tons per square foot. In order to provide for the effects of expansion and contraction, and to allow for the movement occasioned by wind and by the passage of heavy loads across the bridge, the two extremities of the roadway are furnished with jointed ends or flaps, 8ft. long, which give perfect freedom of motion, both vertically and in the direction of the length of the bridge.

The works were commenced at Clifton in November, 1862, by Messrs. Cochrane, the contractors, under the superintendence of their resident manager, Mr. Airey, and the bridge was opened for public traffic on December 8, 1864. The total cost of the ironwork, including the purchase of the chains of the Hungerford bridge, and their carriage to Clifton, was £34,975. Previous to opening the bridge, it was tested by a dead weight of 500 tons of stone, distributed over the surface, when a total deflection was produced of 7in. in the centre. On the removal of the test load, the centre of the bridge rose to its former position within one-sixteenth of an inch, but the middle of the southern half of the bridge did not rise again to its former height by one inch, while the northern side rose above its original position. This was probably due to the change in the direction and force of the wind before and after the testing.

The most severe strain which the bridge had to resist was that resulting from heavy gales of wind, especially those from the north-west or south-east, being nearly in the direction of the deep gorge of the river Avon at the place where the bridge was constructed. On these occasions three effects were observed. First, there was a small horizontal deflection, which was just sufficient to be perceptible to the eye when placed in range with the suspension rods. Secondly, there was an undulation from end to end of the bridge, the maximum fall and rise being, in Mr. Airey's opinion, as much as 6in. above and 6in. below the mean level of the roadway. Thirdly, the land chains, between the piers and the land saddles, which carried no suspension rods, were liable to be deflected laterally, notwithstanding their weight, the longitudinal strain upon them, and the comparatively small surface exposed to the wind.

Considering the facility with which suspension bridges can be constructed, and the comparatively inexpensive nature of the scaffolding, or temporary staging, required for erecting them, there appears to be no reason, in the author's opinion, why spans of much greater magnitude should not be accomplished. The spans already crossed by bridges on this principle far exceed those of any form of girder. The largest girder ever built is that of the Britannia Bridge over the Menai Straits, which is 460ft. between the bearings. The largest suspension bridge is that at Fribourg, which is stated to be 880ft.; while the Niagara Suspension Bridge is 820ft. from centre to centre of the towers, and has been in daily use for nearly twelve years for the passage of railway trains. Suspension bridges have not hitherto been adopted in this country for railway purposes, under the impression that the principle of construction necessarily involved such an amount of flexibility as to render them unfit for the passage of trains; but it must be considered that the larger the bridge, and the greater the ratio of the weight of the bridge to the weight of the moving load, the less will be the disturbance of form caused by a passing load. Moreover it is quite practicable to stiffen a suspension bridge so as to render it nearly as rigid as a girder, of which the Lambeth Bridge, from the designs of Mr. P. W. Barlow, is an example. The subject of stiffening suspension bridges with the least quantity of material, is one well deserving attention. In a detached girder, the upper and lower booms must each be

capable of bearing the strains produced by the weight of the bridge and its load, and the diagonals must be strong enough to transmit the whole of those strains, whereas, in a stiffened suspension bridge, the chain is the only member required to bear the strains produced by the weight of the bridge and its load, while the diagonal bracing, or stiffening, need be no more than just sufficient to prevent disturbance from the moving load. In relation to this subject the author has found by experiments on solid bars, made in 1858, as well as from a theoretical investigation of the case as applied to lattice girders, that, in a continuous girder, if, instead of using an equal depth throughout, a greater depth and a greater sectional area are given over the piers, an increase of strength is obtained in a much higher ratio than that of the increased weight of metal employed.

There is another point deserving of consideration, viz., which is the best form of link and fastening for the chains of a suspension bridge? To this subject Sir Charles Fox (M. Inst. C.E.), has directed attention. But where the object is to construct bridges of very large span, another, and perhaps the most important consideration, is the employment of a stronger material. In this respect the introduction of steel is calculated to have a marked influence. Many of the properties of steel are at present unknown, but it has been determined, by experiments, that its tensile strength is nearly double that of wrought iron, and that it can be made quite as malleable. Its powers of resistance to compression do not show the same proportion of strength, but in the application of steel to the chains of a suspension bridge it is the tensile strength which operates.

ROYAL SOCIETY.

ABSTRACT OF THE RESULTS OF THE COMPARISONS OF THE STANDARDS OF LENGTH OF ENGLAND, FRANCE, BELGIUM, PRUSSIA, RUSSIA, INDIA, AUSTRALIA, MADE AT THE ORDNANCE SURVEY OFFICE, SOUTHAMPTON.

By Capt. A. R. Clarke, R.E., F.R.S., &c., under the direction of Col. Sir Henry James, R.E., F.R.S., &c., Director of Ordnance Survey.

In the preface to this paper, Sir Henry James gives an account of the circumstances under which the work was undertaken, as follows. Table of results is appended.

The principal triangulation of the United Kingdom was finished in 1851; and the triangulations of France, Belgium, Prussia, and Russia were so far advanced in 1860, that, if connected, we should have a continuous triangulation from the Island of Valentia on the south-west extremity of Ireland, in north latitude 51° 55′ 20″, and longitude 10° 20′ 40″ west of Greenwich, to Orsk on the River Ural in Russia.

It was therefore possible to measure the length of an arc of parallel in latitude 52° of about 75°, and to determine, by the assistance of the electric telegraph, the exact difference of longitude between the extremities of this arc, and thus obtain a crucial test of the accuracy of the figure and dimensions of the earth, as derived from the measurement of the arcs of meridian, or the data for modifying the results previously arrived at.

The Russian Government, therefore, at the instance of M. Otto Struve, Imperial Astronomer of Russia, invited (in 1860) the co-operation of the Governments of Prussia, Belgium, France, and England, to effect this most important object, and to their great honour they all consented, and granted the necessary funds for the execution of the work.

The portion of the work which was assigned to me, was the connection of the triangulation of England with that of France and Belgium, and I published the results of this operation in 1862.* But this work has been done in duplicate; for when application was made to the French Government to permit the necessary observations to be made in France, they not only consented to allow this, but at the same time volunteered to join in the labour and expense of the work itself.

It would obviously have been wrong to mix up observations made with different kinds of instruments and on different principles, and therefore it was agreed that the work should, in fact, be made in duplicate, both the French and English geometricians using exactly the same stations.

The results obtained by the French geometricians are published in the Supplement to vol. ix. of the "Mémorial du Dépôt Général de la Guerre," 1865, and the agreement with the results obtained by the English is truly surprising.

But however accurately the trigonometrical observations might be performed, it is obvious that, without a knowledge of the exact relative lengths of the standards used as the units of measure in the triangulation of the several countries, it would be impossible accurately to express the length of the arc of parallel in terms of any one of the standards.

It was therefore necessary that a comparison of the standards of length should be made, and as we had a building and apparatus expressly erected for the purpose of comparing standards at this office, the English Government, on my recommendation, invited the Governments of the several countries named to send their standards here, and we have had the following compared with the greatest accuracy:—

Measures.	Expressed in Terms of the Standard Yard. 𝔜.	Expressed in inches. Inch = $\frac{1}{36}$ 𝔜.	Expressed in lines of the Toise. Line = $\frac{1}{864}$ 𝔗.	Expressed in Millimetres. Millimetre = $\frac{1}{1000}$ 𝔐.
The Yard	1·00000000	36·000000	405·34622	914·39180
Copy No. 55 of the Yard at its Standard Temperature of 62·00°F.	0·99999960	35·999986	405·34606	914·39143
Ordnance Standard Foot ,, ,, ,, 62·00	0·33333284	11·999982	135·11521	304·79681
Indian Standard Foot ,, ,, ,, 62·00	0·33333611	12·000100	135·11653	304·79980
Ordnance 10-foot Bar O_1 ,, ,, ,, 62·00	3·33333717	120·000138	1351·15563	3047·97616
Ordnance 10-foot Bar OI_1 ,, ,, ,, 62·00	3·33335432	120·000755	1351·16259	3047·99184
Indian 10-foot Bar 1s ,, ,, ,, 62·00	3·33340138	120·002450	1351·18166	3048·03488
Indian 10-foot Bar 1B ,, ,, ,, 62·00	3·33353284	120·007182	1351·23495	3048·15508
Indian 10-foot Bar 1*b* ,, ,, ,, 62·00	3·33331457	119·999324	1351·14647	3047·95550
Australian Standard O_4 ,, ,, ,, 62·00	3·33330427	119·998954	1351·14230	3047·94608
Australian Standard O1 ,, ,, ,, 62·00	3·33333747	120·000149	1351·15576	3047·97644
Ordnance Toise ,, ,, ,, 61·25	2·13166458	76·739925	864·06219	1949·17660
Ordnance Metre ,, ,, ,, 61·25	1·09374800	39·374928	443·34662	1000·11420
Royal Society's Mètre à traits ,, ,, ,, 32·00	1·09360478	39·369772	443·28857	999·98324
Prussian Toise, No. 10 ,, ,, ,, 61·25	2·13150911	76·734328	863·99917	1949·03444
Belgian Toise, No. 11 ,, ,, ,, 61·25	2·13150851	76·734306	863·99893	1949·03390
Russian Double Toise P ,, ,, ,, 61·25	4·26300798	153·468287	1727·99419	3898·05952
The Toise	2·13151116	76·734402	864·00000	1949·03632
The Metre	1·09362311	39·370432	443·29600	1000·00000

1. Russian standard, double toise, P.
2. Prussian standard toise.
3. Belgium standard toise.
4. Platinum metre of the Royal Society, compared with the standard metre of France by M. Arago.
5. English standard yards, A, B, C, 29, 47, 51, 55, 58.
6. Ordnance Survey 10-foot standard bar.
7. Indian 10-foot standard bars, new and old.
8. Australian 10-foot standard bar.
9. In addition to the above, the 10-foot standard bar of the Cape of Good Hope was compared here in 1844.

We have invited the Governments of Austria, Spain, and the United States of America, also to send their standards. We have been promised that of Austria, and, but for the unfortunate war in which she has been lately engaged, we should have received it before this.

I have entrusted the execution of the work of comparison and the drawing-up of the results to Capt. Alexander R. Clarke, of the Royal Engineers, who designed the apparatus used. The numerous comparisons to be made entailed a great amount of labour upon him and his assistants, Quartermaster Steel and Corporal Compton, of the Royal Engineers.

* Extension of the Triangulation of the Ordnance Survey into France and Belgium. London, 1863.

Before the connection of the triangulation of the several countries into one great network of triangles, extending across the entire breadth of Europe, and before the discovery of the electric telegraph and its extension from Valentia to the Ural Mountains, it was not possible to execute so vast an undertaking as that which is now in progress. It is, in fact, a work which could not possibly have been executed at any earlier period in the history of the world. The exact determination of the figure and dimensions of the earth has been the great aim of astronomers for upwards of two thousand years, and it is fortunate that we live in a time when men are so enlightened as to combine their labours to effect an object desired by all, and at the first moment when it was possible to execute it.

ROYAL INSTITUTION OF GREAT BRITAIN.

ON SOUNDING AND SENSITIVE FLAMES.

By John Tyndall, Esq., LLD., F.R.S., Professor of Natural Philosophy, &c.

Historical.

The sounding of a hydrogen flame when closed within a glass tube was, I believe, first noticed by Dr. Higgins, in 1777. The subject has been since investigated by Chiadini, De la Rive, Faraday, Wheatstone, Rijke, Sondhauss, and Kundt. The action of unisonant sounds on flames enclosed in tubes has been investigated by Count Schaffgotsch and myself. The jumping of a naked fish-tail flame, in response to musical sounds, was first noticed by Professor Leconte at a musical party in the United States. He made the important observation that the flame did not jump until it was near flaring. That his discovery was not further followed up by this learned investigator was probably due to too great a stretch of courtesy on his part towards myself.* Last year, while preparing the experiments for one of my "Juvenile Lectures," my late assistant, Mr. Barrett, observed the effect independently; and he afterwards succeeded in illustrating it by some very striking experiments. With a view to the present discourse, and also to the requirements of a forthcoming work on sound, the subject of sounding and sensitive flames has been recently submitted to examination in the laboratory of the Royal Institution. The principal results of the inquiry are embodied in the following abstract.

Abstract of Lecture.

Pass a steadily-burning candle rapidly through the air, you obtain an indented band of light, while an almost musical sound heard at the same time announces the rhythmic character of the motion. If, on the other hand, you blow against a candle-flame, the fluttering noise produced indicates a rhythmic action.

When a fluttering of the air is produced at the embouchure of an organ-pipe, the resonance of the pipe reinforces that particular pulse of the flutter whose period of vibration coincides with its own, and raises it to a musical sound.

When a gas-flame is introduced into an open tube of suitable length and width, the current of air passing over the flame produces such a flutter, which the resonance of the tube exalts to a musical sound.

Introducing a gas-flame into this tin tube 3ft. long, we obtain a rich musical note; introducing it into a tube 6ft. long, we obtain a note an octave deeper—the pitch of the note depending on the length of the tube. Introducing the flame into this third tube, which is 15ft. long, the sound assumes extraordinary intensity. The vibrations which produce it are sufficiently powerful to shake the pillars, floor seats, gallery, and the five or six hundred people who occupy the seats and gallery. The flame is sometimes extinguished by its own violence, and ends its peal by an explosion as loud as a pistol shot.

The roar of a flame in a chimney is of this character: it is a rude attempt at music.

By varying the size of the flame, these tubes may be caused to emit their harmonic sounds.

Passing from large tubes to small ones, we obtain a series of musical notes, which rise in pitch as the tube diminishes in length. This flame, surrounded by a tube 17¾in. long, vibrates 459 times in a second, while that contained in this tube, 10¾in. long, vibrates 717 times in a second. Owing to the intense heat of the sounding column, these numbers are greater than those corresponding to organ-pipes of the same lengths sounding in air.

The vibrations of the flame consist of a series of partial extinctions and revivals of the flame.

The singing flame appears continuous; but if the head be moved to and fro, or if an opera-glass, directed to the flame, be caused to move to and fro; or if, after the method of Wheatstone, the flame be regarded in a mirror which is caused to rotate, the images due to the revivals of the flame are separated from each other, and form a chain of flames of great beauty.

With a longer tube and larger flame, by means of a concave mirror, I can project this chain of flames upon a screen. I first clasp my hand round the end of the tube so as to prevent the current of air which causes the flutter from passing over the flame—the image of the flame is now steady upon the screen before you. I move the mirror to and fro, and you have this continuous luminous band: I withdraw my hand; the current of air passes over the flame, and instantly the band breaks up into a chain of images.

A position can be chosen in the tube at which the flame bursts spontaneously into song. A position may also be chosen where the flame is silent, but at which, if it could only be started, it would continue to sound. It is possible to start such a silent flame by a pitch-pipe, by the syren, or by the human voice. It is possible to cause one flame to effect the musical ignition of another.

The sound which starts the flame must be nearly in unison with its own. Both flames must be so near unison as to produce distinct beats.

A flame may be employed to detect sonorous vibrations in air.

Thus, in front of this resonant case, which supports a large and powerful tuning-fork, I move this bright gas-flame to and fro. A continuous band of light is produced, slightly indented through the friction of the air. The fork is now sounded, and instantly this band breaks up into a series of distinct images of the flame.

Approaching the same flame, towards either end of one of our tin tubes, with the sounding flame within it, and causing it to move to and fro, the sonorous vibrations also effect the breaking up of the band of light into a chain of images.

In this glass tube, 14in. long, a flame is sounding; I bring the flat flame of a fish-tail burner over the tube, the broad side of the flame being at right angles to the axis of the tube. The fish-tail flame instantly emits a musical note of the same pitch as that of the singing-flame, but of different quality. Its sound is, in fact, that of a membrane, the part of which it here plays.

Against a broad bat's wing flame I allow a sheet of air, issuing from a thin slit, to impinge. A musical note is the consequence. The note can be produced by air or by carbonic acid; but it is produced with greater force and purity by oxygen. The pitch of the note depends on the distance of the slit from the flame.

Before you burns a bright candle-flame; I may shout, clap my hands, sound this whistle, strike this anvil with a hammer, or explode a mixture of oxygen and hydrogen. Though sonorous waves pass in each case through the air, the candle is absolutely insensible to the sound; there is no motion of the flame.

I now urge from this small blow-pipe a narrow stream of air through the flame of the candle, producing thereby an incipient flutter, and reducing the brightness of the flame. I now sound the whistle; the flame jumps visibly. Matters may be so arranged that when the whistle sounds, the flame shall be either almost restored to its pristine brightness, or that the amount of light it still possesses shall disappear.

Before you now burns a bright flame from a fish-tail burner. I may, as before, shout, clap my hands, sound a whistle, or strike an anvil; the flame remains steady and without response. I urge against the broad face of the flame a stream of air from the blow-pipe just employed. The flame is cut in two by the stream of air. It flutters slightly, and now when the whistle is sounded the flame instantly starts. A knock on the table causes the two half-flames to unite and form for an instant a flame of the ordinary shape. By a slight variation of the experiment, the two side-flames disappear when the whistle is sounded, and a central tongue of flame is thrust forth in their stead.

Passing from a fish-tail to a bat's-wing burner, I obtain this broad steady flame. It is quite insensible to the loudest sound which would be tolerable here. The flame is fed from this gas-holder, which places a power of pressure at my disposal unattainable from the gas-pipes of the Institution. I turn on more gas; the flame enlarges, but it is still insensible to sound. I enlarge it still more, and now a slight flutter of its edge answers to the sound of the whistle. Turning on a little more gas, and sounding again, the jumping of the flame is still more distinct. Finally I turn on gas until the flame is on the point of roaring, as flames do when the pressure is too great. I now sound my whistle; the flame roars and thrusts suddenly upwards eight long quivering tongues.

I strike this distant anvil with a hammer, the flame instantly responds by thrusting forth its tongues.

Another flame is now before you. It issues from a burner, formed of ordinary gas-tubing by my assistant. The flame is 18in. long, and smokes copiously. I sound the whistle; the flame falls to a height of 9in., the smoke disappears, and the brilliancy of the flame is augmented.*

Here are two other flames, also issuing from burners formed by my assistant. The one of them is long, straight, and smoky; the other is short, forked, and brilliant. I sound the whistle; the long flame becomes short, forked, and brilliant; the forked flame becomes long and smoky. As regards, therefore, their response to the sonorous waves, the one of these flames is the exact complement of the other.

Here are various flat flames, ten inches high, and about 3in. across at their widest part. They are purposely made forked flames. When the whistle sounds, the plane of each flame turns 90 degrees round, and continues in its new position as long as the whistle continues to sound.

Here again is a flame of admirable steadiness and brilliancy, issuing from a

* The observation of Professor Leconte is thus graphically described: "Soon after the music commenced, I observed that the flame of the last-mentioned burner exhibited pulsations in height which were exactly synchronous with the audible beats. This phenomenon was very striking to every one in the room, and especially so when the strong notes of the violencello came in. It was exceedingly interesting to observe how perfectly even the trills of this instrument were reflected on the sheet of flame. A deaf man might have seen the harmony. As the evening advanced, and the diminished consumption of gas in the city increased the pressure, the phenomenon became more conspicuous. The jumping of the flame gradually increased, became somewhat irregular and, finally it began to flare continuously, emitting the characteristic sound indicating the escape of a greater amount of gas than could be properly consumed. I then ascertained by experiment, that the phenomenon did not take place, unless the discharge of gas was so regulated, that the flame approximated to the condition of flaring. I likewise determined by experiment, that the effects were not produced by jarring or shaking the floor and walls of the room by means of repeated concussions. Hence it is obvious that the pulsations of the flame were not owing to indirect vibrations propagated through the medium of the walls of the room to the burning apparatus, but must have been produced by the direct influence of aërial sonorous pulses on the burning jet."—"Phil. Mag." 4th series, vol. xv., March, 1858, p. 235; and "Silliman's American Journal," Jan., 1858.

* Mr. Barrett also observed the increase of light on the shortening of a flame by a musical sound; nor did the superior effect of high notes escape the attention of this acute and skilful young experimenter.

single circular orifice in a common iron nipple. I whistle, clap my hand, strike the anvil, and produce other sounds: the flame is perfectly steady. Observe the gradual change from this apathy to sensitiveness. The flame is now four inches high. I make its height six inches; it is still indifferent. I make it ten inches; a barely perceptible quiver responds to the whistle. I make it fourteen inches high, and now it jumps briskly the moment the anvil is tapped or the whistle sounded. I augment the pressure; the flame is now sixteen inches long, and you observe a quivering which announces that the flame is near roaring. I increase the pressure; it now roars, and shortens at the same time to a height of eight inches. I diminish the pressure a little; the flame is again sixteen inches long, but it is on the point of roaring. It stands as it were on the brink of a precipice. The whistle pushes it over. Observe it shortens when the whistle sounds, exactly as it did when the pressure was in excess. The sonorous pulses, in fact, furnish the supplement of energy necessary to produce the roar and shorten the flame. This is the simple philosophy of all these sensitive flames.

The pitch of the note chosen to push the flame over the brink is not a matter of indifference. I have here a tuning-fork which vibrates 256 times in a second, emitting a clear and forcible note. It has no effect upon this flame. Here are three other forks, vibrating respectively 320, 384, and 512 times in a second. Not one of them produces the slightest impression upon the flame. But, besides their fundamental tones, these forks can be caused to sound a series of overtones of very high pitch. I sound this series of tones: the vibrations are now 1,600, 2,000, 2,400, and 3,200 per second respectively. The flame jumps in response to each of these sounds; the response to the highest tone of the series being the most prompt and energetic of all.

To the tap of a hammer upon a board the flame responds, but to the tap of the same hammer upon an anvil the response is much more brisk and animated. The reason is, that the clang of the anvil is rich in the higher tones to which the flame is most sensitive.

Here again is an inverted bell, which I cause to sound by means of a fiddle-bow, producing a powerful tone. The flame is unmoved. I bring a halfpenny into contact with the surface of the bell: the consequent rattle contains the high notes to which the flame is sensitive. It instantly shortens, flutters, and roars when the coin touches the bell.

Here is another flame, twenty inches long. I take this fiddle in my hand, and pass a bow over the three strings which emit the deepest notes. There is no response on the part of the flame. I sound the highest string: the jet instantly squats down to a tumultuous bushy flame, eight inches long. I have here a small bell, the hammer of which is caused to descend by clockwork. I hold it at a distance of twenty yards from the flame. The strokes follow each other in rythmic succession, and at every stroke the flame falls from a height of twenty to a height of eight inches.

The rapidity with which sound is propagated through air is well illustrated by these experiments. There is no sensible interval between the stroke of the bell and the shortening of the flame.

Some of these flames are of marvellous sensibility; one such is at present burning before you. It is nearly twenty inches long, but the slightest tap on a distant anvil knocks it down to eight. I shake this bunch of keys or these few copper coins in my hand: the flame responds to every tinkle. I may stand at a distance of twenty yards from this flame: the dropping of a sixpence from a height of a couple of inches into a hand already containing coin, knocks the flame down. I cannot walk across the floor without affecting the flame. The creaking of my boots sets it in violent commotion. The crumpling of a bit of paper, or the rustle of a silk dress, does the same. It is startled by the plashing of a raindrop. I speak to the flame, repeating a few lines of poetry; the flame jumps at intervals, apparently picking certain sounds from my utterance to which it can respond, while it is unaffected by others.

In our experiments down stairs we have called this the vowel flame, because the different vowel-sounds affect it differently. Vowel-sounds of the same pitch are known to be readily distinguishable. Their qualities or clang-tints are different, though they have a common fundamental tone. They differ from each other through the admixture of higher tones with the fundamental. It is the presence of these higher tones in different proportions that characterises the vowel sounds; and it is to these same tones, and not to the fundamental one, that our flame is sensitive. I utter a loud and sonorous U, the flame remains steady; I change the sound to O, the flame quivers; I sound E, and now the flame is affected strongly. I utter the words *boot*, *boat*, and *beat* in succession. To the first there is no response; to the second, the flame starts; but by the third and fourth it is thrown into violent commotion. The sound *Ah!* is still more powerful. When the vowel sounds are analysed their constituents are found to vary in accordance with the foregoing experiments; those characterised by the sharpest overtones being the most powerful excitants of the flame. (See Helmholtz in Pogg. Annalen, vol. cviii., p. 286.)

The flame is peculiarly sensitive to the utterance of the letter S. If the most distant person in the room were to favour me with a "hiss," the flame would be instantly shivered into tumult. The utterance of the word "hush," or "puss," produces the same effect. This hissing sound contains the precise elements that most forcibly affect the flame. The gas issues from its burner with a hiss, and an external sound of this character added to that of a gas-jet already on the point of roaring is equivalent to an augmentation of pressure on the issuing stream of gas. I hold in my hand a metal box containing compressed air. I turn the cock for a moment, so as to allow a puff to escape: the flame instantly ducks down; not by any transfer of air from the box to the flame, for I stand at a distance which utterly excludes this idea; it is the sound of the issuing air that affects the flame. The hiss produced in one orifice precipitates the tumult at the other.*

* Those who wish to repeat these experiments would do well to bear in mind, as an essential condition of complete success, that a free way should be open for the transmission of the vibrations from the flame backwards through the gaspipe which feeds it. The orifices of the stopcocks near the flame ought to be as wide as possible.

Finally, I place this musical box on the table, and permit it to play. The flame responds like a sentient creature, curtseying to the notes to which it is sensitive.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

The following is an abstract of the Chief Engineer's Monthly Report presented at the ordinary monthly meeting of the Executive Committee of this Association held at the Offices, 41, Corporation-street, Manchester, on Tuesday, January 8th, 1866, Hugh Mason, Esq., of Ashton-under-Lyne, Vice-President, in the chair.

"During the last month 333 engines and 577 boilers have been examined, and one of the latter tested by hydraulic pressure. Of the boiler examinations, 388 have been external, 7 internal, and 182 entire. In the boilers examined, 79 defects have been discovered, 7 of those being dangerous. They consisted in 46 defects in boilers proper, 17 defective fittings, and 16 omissions.

One case of fracture was of a very serious character. It was met with in a plain cylindrical egg-ended, externally-fired boiler, 35ft. long, and 5ft. 6in. in diameter, the thickness of the plates being $\frac{3}{8}$ of an inch, and the blowing-off pressure 50lb.

The fracture took place at the bottom of the boiler, and as nearly as may be midway in its length, while it ran more than half-way round it, and through the outer overlap of the plate. The attendant had just turned off the feed, when he was startled by a report from the boiler, and the ashpit and firing space were flooded with water immediately afterwards. There is no doubt as to the cause of this fracture. The boiler was fed with cold water, and this was carried down by means of an internal feed pipe to within 9 inches of the bottom, and very near to the fractured seam, while the chimney draught was good, and the firing severe. A hot fire, with a cold feed impinging on the bottom of the shell, are sure to distress an externally-fired boiler; and this one had failed only a few months before in a similar manner at the next ring seam of rivets, on the other side of the feed pipe, and about the same distance from it.

It is most important in externally-fired boilers that the feed water should be dispersed as much as possible, and for this purpose it may be introduced through a perforated pipe carried along horizontally for some 5 or 6 feet near to the surface of the water, while it is of advantage to heat the feed in addition.

The most serious case of external corrosion met with during the past month occurred on the side of an ordinary double-flued "Lancashire" boiler, a surface of more than 2ft. square being found, upon the removal of some brickwork which had concealed it, to be so reduced in thickness that the Inspector, on lightly sounding it, sent his hammer right through the plate. It appears that the corrosion was caused by leakage consequent on the very improper way in which the boiler had been repaired, patches being bolted instead of rivetted, and put on layer upon layer, without removing the old work. Fortunately, the pressure was only 12lb., or the consequences might have been serious. The case shows the importance of avoiding all bolted patches in repairing boilers, and of not allowing wide surfaces of brickwork to remain in contact with the plates, without frequent removal for examination, while it is better to dispense with them altogether.

Explosions.

Of the explosions recorded in last month's report, the following may be specially mentioned:

No. 46 Explosion occurred to a boiler not under the inspection of this Association, at a quarter before two on the afternoon of Sept. 25, at a dyeworks, and resulted in the death of seven, and serious injury to two persons, while the works were reduced to a general ruin. This destructive explosion deserves the most serious consideration on account of its peculiarity from an engineering point of view.

On visiting the scene of the catastrophe, at the request of the coroner, two or three days after the explosion had occurred, I found that the boiler was internally-fired and of the Cornish type, having a single furnace tube running throughout from end to end. Its length was 20ft., its diameter in the shell 4ft. 6in., and in the furnace tube 2ft. 6in., while the thickness of the plates throughout was $\frac{3}{8}$in., with the exception of the flat ends, which were $\frac{1}{2}$in. The cylindrical portion of the shell was composed of six belts, each of which was about 3ft. 8in. wide, including the overlap, and being composed of two plates circumferentially, had two longitudinal seams of rivets. These seams were placed at the sides of the boiler in the first belt, counting from the firing end, and at the top and bottom in the second, while they were at the sides in the third, and so on alternately throughout. The boiler had but one safety-valve, of open lever construction, measuring 3in. in diameter, and weighted to about 100lbs. on the square inch, which was the pressure for which the boiler had been originally made; it was double-rivetted throughout at the longitudinal, as well as at the circular seams, both in the shell and furnace tube.

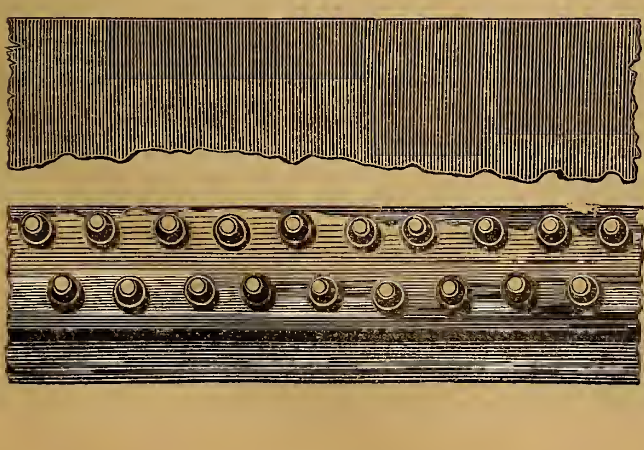
The boiler gave way in the external shell, but in a somewhat unusual manner, the third belt of plates, reckoning from the firing end, being cut out of the shell, without damaging the remainder of the boiler, almost as neatly as if it had been turned out by a tool in the lathe. This belt had rent primarily across its entire width at a longitudinal seam of rivets, and secondarily at the ring seams running round the boiler at each side of it. The boiler was moved but a few feet from its seating, but the belt of plate just described was opened out nearly flat and thrown across the yard to the right hand of its original position, while the works were completely laid in ruins, and the *débris* scattered in every direction, the dismantled moulding at the top of the chimney stack showing that some of the fragments must have been thrown to a considerable height.

Though the pressure at which this boiler was worked, viz., 100lbs. on the

square inch, was high, yet it was not excessive for one of such dimensions as this one was, if well made aud of good material, while many boilers, strained as severely, are working with perfect safety. When the boiler was ordered, it was distinctly stipulated that it should be safe at the pressure just named, and it was made on this understauding, being double-rivetted throughout in consequence, and tested with water up to a pressure of 240lbs. per square inch by the makers, who warranted it safe, and described it in their correspondence as a splendid boiler, and one that would do them credit. Its price, without fittings, was £120, which, considering the small size of the boiler, was a high one, but which the makers said was due to the superiority of their work. The boiler scarcely worked, however, six months before it burst, though the plates were not thinned by corrosion, but retained their original thickness. It will be seen, therefore, that this is by no means an ordinary explosion, and it is important clearly to ascertain its cause.

It must be apparent at a glance that this explosion could not be due to shortness of water, since the boiler, though internally-fired, failed in the external shell, aud not in the furnace tube; but it may be added that the furnace crown did not present the slightest appearance of overheating, being slightly scaled over, and retaining its shape as truly as wheu first made. Neither is there any reason to conclude that the working pressure had been exceeded, since, on extricating the safety-valve after the explosion from the *débris* in which it was buried, it was found to be free iu action, while all the witnesses, who gave evidence on this subject at the inquest, concurred in the statemeut that the blowing-off pressure was 100lbs. as nearly as may be, and no one appeared to have seen this exceeded. It may also be pointed out that the rupture of the boiler appears of too local a character to have resulted from an excessive pressure of steam, since this would have operated equally over the whole shell; while, further, the furnace tube, not being strengthened with any encircling hoops, but merely with three segments on the crown, was weaker than the external shell, so that, had the explosion resulted from an uudue and excessive pressure of steam, it might reasonably be concluded that the furnace tube would have failed before the shell, whereas the shell gave way, and not the furnace tube. The questions of shortness of water and improper pressure of steam have been alluded to, since they are so generally supposed to have to do with nearly every explosion, but to arrive at the true cause in the present instance, attention must be directed to the primary rent. This occurred at the iuner overlap of the plate of a longitudinal double-rivetted joint, but it did not take the line of rivet holes throughout, but appeared to have commenced at the solid metal, and about midway in the length of the seam at the edge of the overlap, and at the line of caulking, which it followed for a length of 4 or 5ins., and then sloped into the line of rivets. The edge of the plate exhibited a very short brittle fracture, and on examining the shell for the brand, only one of the plates was fouud to have any mark on it at all, and this was the single word "Boiler," while at the inquest the foreman, under whose superintendence the boiler had been made, frankly acknowledged that the fractured plate was not of good quality, and would not have been put into the boiler had he known it. The edge of the fractured plate appeared to contain an old flaw at the line of caulking, just as if a crack had been started either when the boiler was first made or when it was caulked at the time of testing with water pressure up to 240lbs., and had gradually gone on developing till it extended right across the plate. That this crack had existed for some time is corroborated by the fact that this seam of rivets had been found to leak a month or so before the explosion, and was caulked in consequence, while in addition the boiler had leaked on the morning of the explosion, when the maker was sent for to examine it, but as the joint could not be got at with steam up, repairs were deferred till the brickwork could be removed on the following Saturday, when the boiler would be stopped. This leakage was on the same side of the boiler as the primary rent, and from the position of the moisture on the brick work, there is good reason to conclude that the water came from the same seam that had previously proved defective and rent a few hours afterwards. Having regard to all the circumstances of the case, the position and character of the rents, the condition of the furnace crown, the brittle character of the plate, and the repeated leakages at the seam of rivets at which the primary rent occurred, &c., there can be no question that the explosion was not due to shortness of water, or an improper amount of steam, but that it occurred at a pressure not exceeding that at which the boiler was ordinarily worked, simply from weakness consequent on defective material combined with injudicious workmanship, or in short, that the boiler burst because it was a bad one.

FIG. 1.



This explosion affords a forcible illustration of the sad results of putting in bad plates, the purchaser's works being laid in ruins, though he covenanted for a good boiler, and paid an ample price for it, so that the *onus* of the explosion must rest entirely with the boiler maker.

The annexed illustration represents a piece cut off each end of the belt of plate severed from the boiler, the fracture at the double line of rivets being at a longitudinal seam, and those at right angles with it, and ou each side of the plate, at a circumferential one. The rivets, which had a diameter of $\frac{11}{16}$ in. in the body, $1\frac{1}{8}$ in. in the beaten head, were set out so as to form a series of triangles which were almost equilateral, and measured $2\frac{1}{8}$ ins. in the directiou of the seam, and $2\frac{1}{4}$ in. diagonally, the two rows being spaced 2 in. apart, measuring in each case from centre to centre, while the overlap of the plates was $1\frac{1}{8}$ iu. from the edge to the centre of the rivets. The riveting was done by hand, and not by machine, but the heads were carefully snapped, and presented a ueat appearance to the eye, though it may be pointed out that they were rather light.

It is thought for so high a pressure as 100 lb. on the square inch, and with plates only $\frac{3}{8}$ iu. iu thickness, that the rivets were spaced too far apart, and it would have been better had their diameter been $\frac{3}{4}$ in., instead of $\frac{11}{16}$ in. and the overlap somewhat less than $1\frac{1}{8}$ in. from the centre of the rivet to the edge of the plate; and, further, that machine-riveting would have given a bolder and fuller head to the point of the rivet, and have drawn the work up tighter together, so that it would have required less caulking, from which so much mischief was evidently done in the present instance. It is not wished to express too decided an opinion upon these points, but rather to call attention to them as worthy of further consideration; and it is trusted that the details given above of the seam of rivets which failed, with such disastrous consequences, will prove of service to those interested in this subject, which a more general introduction of high pressure steam and double riveting renders of daily increasing importance.

On the present occasion I have to report seven explosions, by which five persons were killed and fifteen injured. The details of three of these explosions will be found below. Ou referring to the following tabular statement of explosions it will be seen that the highest progressive number is 61; but to this 12 others must be added; so that the total number of explosions that have come under my notice for the year 1866 is 73, by which 87 persons were killed, and 110 injured. It is possible, however, that this does not include the total number of explosions that have occurred, since some may have escaped my notice.

One of these explosions occurred to a boiler under the charge of this Association, but the boiler had not been guaranteed, on account of the defective shape of its internal flue-tube, the danger of which had been pointed out to the owner when the boiler was enrolled. Full particulars will be found under the head of No. 55 Explosion iu this report. No explosiou has occurred to any of the boilers the safety of which has been guaranteed by this Associatiou since the adoption of the guarantee system at the commencement of 1865.

TABULAR STATEMENT OF EXPLOSIONS, FROM NOVEMBER 24TH, 1866, TO DECEMBER 31ST 1866, INCLUSIVE.

Progressive No. for 1866.	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
55	Nov. 26	Double-furnace Water Tube. Iuternally-fired	0	0	0
56	Dec. 1	Locomotive type. Internally-fired	3	2	5
57	Dec. 4	Particulars not yet fully ascertained..................	1	9	10
58	Dec. 12	Egg-ended. Externally-fired	1	0	1
59	Dec. 15	Puddling Furnace Horizontal. Externally aud Internally-fired	0	3	3
60	Dec. 23	Single-flue or "Cornish." Internally-fired	0	0	0
61	Dec. 24	Particulars uot yet fully ascertained	0	1	1
		Total..................	5	15	20

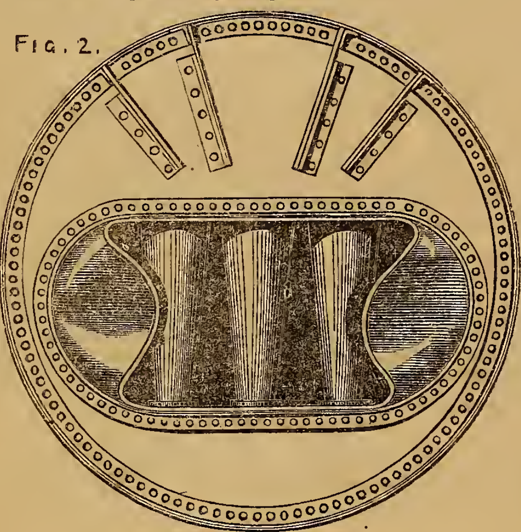
No. 55 Explosion occurred at eleven o'clock on the morning of Monday, November 26, at a paper mill, through the collapse of a mal-constructed internal-flue tube. This boiler was under the iuspection of this Association, but the weakness and consequent danger of the flue tube had been clearly pointed out to the owner by the Association's Chief Engineer at the time the boiler was enrolled, when it was also explained that its safety could not be guaranteed, until the flue has been radically strengthened, or replaced by a new one, while this warning was repeated from time to time in the Association's written reports to the member on the condition of his boilers.

The explosion was not attended with any serious consequences. No one was either killed or injured, while the damage to the surrounding property was confined to the blowing up of a brickwork flue at the back of the boiler by the torrent of steam and hot water that rushed from the boiler; and though this took place at both ends of the flue, the attendants in the firing space at the front of the boiler escaped unhurt, not being directly opposite the furnace mouths. The boiler was one of a series of six set side by side, three of them being to the left and two to the right of the exploded one, but neither the exploded boiler nor any of the others were stirred from their seat; and though they were all connected together, the steam-pipe joints were not broken, so that as soon as the exploded boiler was disconnected by screwing down the junction valve, the remainder of the series were ready to resume work, and they did so after waiting a few hours for the brickwork flue to be repaired.

The boiler was of patent construction, having two furnace tubes, which, instead of running right through the shell, as in those of the ordinary flued class, united behind the fire bridge in a single flue or combustion chamber of oval shape. This oval flue was strengthened by vertical conical water tubes, which, at the same time that they acted as stays, promoted the circulation of the water. The boiler was 7 ft. in diameter and 28 ft. long, while the oval flue or combustion chamber measured about 4 ft. 11 in. in width, and 2 ft. 8 in. in height, the thickness of the plates being $\frac{7}{16}$ in. in the shell, $\frac{3}{8}$ in. in the furnace tubes, and $\frac{5}{16}$ in. in the sides of the oval flue or combustion chamber, while the pressure of the steam was 50 lbs. per square inch.

The construction of the flue in question will perhaps be better understood on reference to the following wood engravings.

FIG. 2.



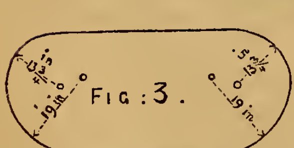


FIG: 3.

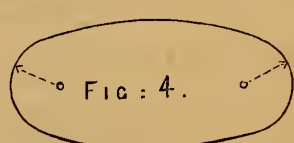


FIG: 4.

Fig. 2 is a cross section of the boiler, showing the shape that the sides of the flue assumed after collapse. Fig. 3 is a diagram giving a profile view of the objectionable form of flue with the sides struck from the two centres. This is now discarded in all new boilers. Fig. 4 shows the improved form of flue now adopted in the place of Fig. 3, having the sides in one sweep throughout, and struck from a single centre only.

It is to be borne in mind that the danger was fully anticipated and faithfully pointed out in the Association's reports to the owner of the boiler, who frankly acknowledged the service rendered, and had ordered a new boiler in consequence about a week before the explosion occurred, and is now rapidly removing all others on his works of a construction similar to the exploded one.

No. 56 Explosion took place a few minutes before nine on the morning of Saturday, December 1st, and resulted in three deaths, and two cases of severe personal injury. The boiler, which was not under the inspection of this Association, was employed at a boat-builder's yard for driving circular saws. It was somewhat of the locomotive type, being fired internally, and having a square stayed fire-box, a cylindrical barrel, and internal flue tubes. These tubes were five in number, the two lower ones, which measured 4 ft 6 in. in length and 11 in. in diameter, running from the fire-box to a flame chamber at the back of the boiler, while the three upper ones, which measured 6 ft. 6 in. in length, and $8\frac{1}{2}$ in. in diameter, were return tubes, and ran from the flame chamber at the back of the boiler to the smoke box at the front, passing over the crown of the fire-box in their way. The boiler was but small, its length being about 8 ft., and its diameter in the barrel 3 ft. 6 in., while the inside width of the fire-box was 3ft., and its length 1ft. 9 in. The working pressure was from 35 lb. to 40 lb., which is by no means excessive for this description of boiler.

The boiler burst at the lower set of flue tubes, the right hand one crushing inwards at the bottom, and rending nearly from one end to the other, so that an opening was formed 3 ft. 6 in. long by 8 in. wide at the middle, through which the hot water and steam within the boiler rushed into the firing space with such violence that four lads and a man, sitting near the fire door, were so severely scalded that three of the former died shortly after. The boiler was not rent in the shell, nor moved from its seat, and the damage was confined to that done by the rush of steam and hot water.

The cause of the explosion is extremely simple. There were no signs of overheating, and it will be apparent at a glance that the point of rupture was the last to be affected by shortness of water, being at the underside of the lower row of tubes, while it was found on examination that the ruptured tube, which was 11 in. in diameter, and had originally measured $\frac{1}{4}$ in. in thickness, had been allowed to waste away from corrosion on the flame side of the plates until the metal was reduced to the thickness of a sheet of paper, so that it gave way from simple weakness. This corrosion appears to have been caused by leakage of the tube plate in the flame box, which had recently been repaired with four bolted patches. Had the boiler been thoroughly examined when these repairs were effected, its dangerous condition might have been detected in time to prevent the explosion.

At the inquest, the usual verdict of "accidental death" was returned, but the man in charge of the boiler was severely censured for having exceeded the ordinary working pressure of 35 lb. per square inch. If, however, he only raised it, as reported, to 38 lb., it would appear that the censure was uncalled for, and that the poor man rightly considers himself aggrieved, since such a boiler, if well made and in good condition, would work at a much higher pressure than 38 lbs. with perfect safety, while this explosion is clearly not a question of one or two pounds more or less of steam pressure, but of the dilapidated state of the boiler, since the flue tube which burst would have been one of its strongest parts had it been in good condition. The boiler was fired by a lad of about seventeen years of age, while the man supposed to take charge of it was not an engineer, but employed in the workshop in looking after the saws, and only exercised a general oversight of the boiler. It is thought that the *onus* of the explosion must rest with the proprietor for not providing more competent supervision, and for allowing the boiler to work on in a leaking condition, eating its plates into holes, till it exploded with such fatal results: while the boiler maker who put on the bolted patches but three months before the explosion, and gave some hints to the attendant as to the unsatisfactory state of the boiler, should have clearly pointed out the danger, and his not doing so is only another illustration of the fact that boiler makers are not always reliable inspectors. It is an idle excuse to attribute this disaster to an extra pound or so of steam pressure, and thus to throw the blame upon the attendant. It only serves to distract the attention from the true cause of the explosion, which was simply the dilapidated condition of the boiler, while it may be added that the application of the hydraulic test would have drawn attention to the weakened flue, and given warning of the danger.

No. 59 Explosion, by which three persons were injured, but fortunately no one killed, occurred at an ironworks, at half-past twelve o'clock p.m., on Saturday, December 15th.

The boiler, which was not under the inspection of this Association, was of the "Lancashire" type, having two furnace tubes running through it from end to end, and being internally fired, though it was also heated externally by two puddling furnaces situated at the back end of the boiler, the flames from one of which passed through an external brickwork flue on the right hand side of the boiler, and the other through a similar flue on the left, and thus played on the outside of the shell, so that the boiler was subjected to the action of four fires, two of them, viz., those at the front end being internal, and the two at the back being external. The length of the boiler was about 24ft., the diameter in the shell 6ft. 6in., and in the furnace tubes 2ft. $6\frac{1}{2}$in., the thickness of the plates being $\frac{7}{16}$in. in the former, and $\frac{3}{8}$in. in the latter, while the ordinary pressure of steam was about 50lbs. on the square inch, which was not excessive for such a boiler.

The boiler gave way in the external shell, which rent in a longitudinal direction for a width of about two belts of plate on the right hand side of the boiler, close to the back end, and a little below the level of the furnace crowns. At each end of this primary longitudinal rent, another started in a circumferential direction, one taking the line of the angle iron at the back of the shell, and the other a more irregular course, about two plates off.

The explosion was not caused by corrosion, the boiler being a new one, having been at work only a few months, and no thinning of the plates having taken place, while there was no question, on a consideration of all the circumstances, that the explosion was due to overheating through shortness of water. It would appear that the furnace crowns had been the first to give way, but as they had not rent either at the plates or seams of rivets, it is presumed that they bulged down without making much noise. In consequence of the state of the furnace crowns being unobserved at the time, the boiler was allowed to work on with the flames from the puddling furnaces playing upon the external shell when the plates must have shortly lost their tenacity from overheating, and rent, as already described, in a longitudinal direction, a little below low water line at the back end of the boiler, just where the flames from the puddling furnaces first acted upon it. The question had been raised whether the injury to the furnace crowns did not arise after, rather than before, the explosion took place, since the works were thrown into such a state of confusion that the fires were not drawn from the furnaces until upwards of an hour after the boiler had burst. The explosion, however, had destroyed the connection to the chimney, and thus the fires must soon have lost their intensity, added to which, even if the crowns had been heated to redness, they would not have been bulged downwards, as they were, till they touched the fire-bars, without a pressure of steam, so that there seems no reason to question that the furnace crowns gave way first, and the external shell rent shortly afterwards, if not almost simultaneously. The fireman confidently asserts that the gauge glass indicated plenty

of water, so that it is clear that either he or the glass water gauge must be at fault, for it is certain that the plates of the boiler had been laid bare and over-heated. If the glass gauge were at fault, and showed water in the tube when there was none in the boiler, a duplicate gauge would have acted as a check, while a low-water safety-valve would have let off the pressure of steam on the water's falling below the proper level, from whatever cause that might arise, and thus have given warning of the danger; when, if this had been disregarded, it would have continued blowing off till the works had been brought to a stand-still from the want of steam, instead of by the force of the explosion, as in the present instance.

While this explosion must clearly be attributed to over-heating of the plates through shortness of water, which there is too much reason to fear was due to the negligence of the attendant, yet efficient boiler mountings would have given warning of the danger, and prevented the injury, in spite of the mans' neglect.

INSTITUTION OF ENGINEERS IN SCOTLAND.

ON THE EMPLOYMENT OF STEEL IN SHIPBUILDING AND MARINE ENGINEERING.

By Mr. GEO. BARBER, Surveyor to the Board of Trade, London.

The employment of steel in shipbuilding, and in the construction of marine engines and boilers, is a subject which is just now occupying considerable attention; and the question having been raised, "Whether practically a girder (*e. g.* the hull of a ship) or steam boilers, or the various parts of a steam engine can, for purposes of safety, be made lighter if made of steel than they can if made of iron?" it has occurred to me that such a subject might be considered with profit, and discussed to good purpose, by the Institution of Engineers and Shipbuilders' Association; for I know that many of the members have had experience of the use of steel in shipbuilding, and that many others are able, from practical knowledge, to say whether steel possesses any advantages over iron for marine engines and boilers.

The opinions of practical men respecting the use of steel are very much at variance, and the results of the experiments which have hitherto been conducted have been so widely different from each other as to prevent them being solely relied upon in practice. Some boilers made of steel have, after a certain period of service, been pronounced in better condition than similar boilers, made at the same time, of equal strength of iron, and worked under similar circumstances; and it has been stated that steel boilers, in addition to being in a much better condition, have, during the working, been more free from scale, and have generated more steam, evaporated more water, and consumed less fuel in a given space of time than similar boilers made of iron. Against these statements we have others of a less favourable nature, and we have the fact that steel boilers made by one of the most eminent engineers in the country, had to be taken out of a mail vessel as unserviceable, from defects in the material, after a service of only one year. Then, as to cranks and shafts, while some and perhaps the majority of engineers, speak highly of steel shafts, others, and also some managers of steamboat companies, say that, from the results of their own experience, they cannot place such reliance upon shafts made of steel as upon those made of iron. It may be that those who have expressed the latter opinion have not been fortunate in their selection of steel, and that the defects which have prejudiced them against it might have occurred in iron; but, with the improvements which are daily taking place in its manfacture, defects such as have been discovered will soon be remedied, and it is certain that as the advantages of the use of steel become manifest, it will be more largely employed in the construction of ships and machinery, though perhaps a longer time may elapse before it is considered a suitable material to be generally adopted for marine boilers.

Our experience and information respecting steel-built ships are very limited; but, in the hope that other members of the institution will be induced to do the same, I will now state some of the facts which have come under my own observation, the conclusions which I have come to, and the opinions I have formed upon this important subject.

1. I have surveyed and passed for a passenger certificate steam vessels built of steel which have been less in thickness and weight than similar vessels built of iron. These vessels have "River" and "Excursion" certificates, and the size of the material used in their construction is about one-fourth less than it would have been if they had been built of iron.

2. One of these vessels—the *Samphire*, Dover Mail Packet, of 183 tons net register, and 160 nominal horse-power, whilst on her passage from Dover to Calais on the night of Wednesday. the 13th December last, came into violent collision with the *Fanny Buck*, an American barque of 585 tons, bound from Rotterdam to Cardiff, in ballast. The *Samphire* was struck by the barque on the port bow, and upon a bulk-head about 33ft. from the stem, and a portion of the vessel of about 12ft. in length, and extending from the gunwale down to the lar-board strake and inboard, as far as the thick strakes for the windlass, was completely crushed, broken, and torn away. I examined both vessels shortly after the collision. The stem, thirteen planks of the starboard bow, and some of the timbers and inside stringers of the barque were broken, and pieces of the plating of the steamer were deeply and firmly imbedded in her planks. An examination of the framing and plating of the *Samphire* showed it to be of excellent quality. The beams, which are rolled of I form, 4 × 4 × $\frac{5}{8}$ (with a waterway stringer-plate 15 × 5-16 and 6 × 3 × 5-16 angle steel upon the upper flange, and a shelf plate 9 × 5-16 with two 6 × 4 × 5-16 angle steels under the lower flange) were bent at very sudden curves, but there was no fracture of the skin of the steel. The frames (which are 3 × $2\frac{1}{2}$ × $\frac{1}{4}$, and spaced 18in. apart) had their flanges opened out flat in some parts and crushed quite close in other parts, without showing any crack or flaw, and the plating of the hull and bulkheads 5-16″ and $\frac{1}{4}$″ thick) was twisted and bent into all manner of shapes, but was not cracked. The vessel is carvel or flush built, and is double-riveted throughout; and, although the shock of the collision was so sudden and severe, the riveting all around and in close proximity to the fracture of the hull was quite firm and sound, proving that good workmanship had been combined with good material. The plating of the bottom and sheer strake of this vessel for a length extending 10ft. beyond the bulkheads at each end of the engine and boiler space is doubled. On making inquiries I ascertained that the material used in her construction was described in the specification as "steel iron, of the manufacture of Thomas Firth and Sons, of Whittington Works, Sheffield, and guaranteed not to break at a tensile strain of 35 tons per square inch." Another steel-built vessel of 100 tons net register and 50 H.P., and intended for pleasure traffic along the coast, came under my notice in the early part of this summer. On examining this vessel before she was launched, I could not help remarking to the builder that the plating of the bottom was unusually irregular and unfair; that the position of every frame could be distinctly seen from the outside of the vessel; and that the plating appeared to have buckled or sprung in between the frames, giving an undulating appearance, anything but pleasing to the eye. The riveting of the bottom was unsatisfactory, and the deck beams, which were of 5″ × 2″ × $\frac{1}{4}$″ angle steel, had the same unfair and irregular appearance as the plating of the bottom. The builder and the foreman in charge of the work stated that the framing of the hull was perfectly fair before the plating was commenced, and they attributed the unsatisfactory appearance to the difficulty experienced in working the steel. "It is most troublesome and difficult stuff to work, and buckles and flies in all directions. As soon as we ply it close to one frame, it flies off the next; as soon as we get a beam fair in one place, it twists in another, and we have had no end of trouble with it." It may be that the unfairness of a bottom and the sharp angular projections at every frame caused by the buckling or springing in of the plates between the frames are not detrimental in point of strength, but it occurred to me at the time that if thin steel plates cannot be worked without twisting and buckling, the frames should be spaced more closely together, so as to give more stiffness to the plating, and also a better chance of having the lines of the bottom fair and pleasing to the eye, though this would to some extent counteract the advantage sought to be gained, in point of lightness, by the substitution of steel for iron. In this case the frames were 20in. apart and the plating was 3-16in. thick.

3. I have not passed for "Home Trade" or "Foreign" Service any vessel which has been built wholly of steel.

4. I have seen foreign-going vessels built wholly of steel; but as these vessels were intended for a special service and were built at a time when rapidity of construction was considered of greater importance than a careful selection of material or excellence of workmanship, the results, which in some cases were far from satisfactory, did not afford a fair criterion for judging of the merits of the material.

5. No legislative enactments nor departmental regulations govern or define the mode of construction or the size, amount, or description of material to be used in the steam and sailing vessels of this country. The supervision exercised by Government over vessels engaged in the passenger trade is general in its character, and is directed chiefly to ascertaining that the ship or steamer is suitable and sufficient in every respect for the trade or voyage in which it is to be employed; the surveyors being wholly unfettered by detailed rules or regulations, and held wholly responsible for all matters to which, by the Acts of Parliament, they are required to direct their attention. The rules issued by the Committee of Lloyd's Register are, however (whether ships are to be classed at Lloyd's or not), taken as a guide by nearly every one engaged in, interested in, or consulted with regard to shipbuilding. But steel is not at present recognised in those rules as a material for shipbuilding, and its use in the construction of any vessel proposed for classification is only permitted after the case has been specially submitted to and carefully considered by the Committee and Chief Surveyors of Lloyd's Register.

6. In river steamers, when a light draught of water and a high rate of speed are indispensable, steel may be advantageously employed, for such vessels have not to sustain the weight and strains, or wear and tear of sea-going ships; and as every part of them may at any time be easily got at and examined, internal and external corrosion may be at once arrested.

7. In sea-going vessels the case is different, and I am of opinion that the size of material prescribed by Lloyd's Rules, which have been modified from time to time and are now considered free from objection, should not be diminished until further experience has been gained respecting the efficiency and durability of the material proposed. Steel may possess superior tenacity, but tenacity is not the only property required. The whole of the material should work well in the fire, should not fail when passed through the rollers, or when receiving at the hands of the workmen the sudden twists and curves required in shipbuilding, and the plating of the hull should be of sufficient substance to withstand the sudden concussion of the waves at the bows and sides, the vibration caused at the stern by the motion of the screw propeller, accidental blows from contact with ice or floating bodies, and the reduction in thickness caused by the friction of the water and by external and internal corrosion. Thin plates of steel may, when new, be of greater strength than thicker plates of iron; but, if corrosion goes on at the same rate upon each, the steel plates will, if allowed to be much thinner, become unserviceable in a much shorter time than those of iron.

8. In shipbuilding, good workmanship is as important as good material. I have found when going through the shipbuilding yards of the Mersey, the Clyde, and the Thames, that much greater care is required on the part of the workmen in fitting, working, countersinking, and riveting steel plates, frames, and beams than in working those of iron. I have seen steel plates buckle and fly under the hammer and crack during the process of riveting up. Thin plates of steel will not stand countersinking well; and, if countersunk, there is but little substance left for the body of the rivet. When Low-moor rivets have been used in a steel-built ship, they have been sheared off when the vessel has worked in a sea-way; and when steel rivets have been used, the heads have been known

to fly off when the vessel has bumped against the pier-head, or been suddenly struck by a barge or heavy floating body. Greater care and closer supervision are likewise necessary in the selection of the material. Brittle plates have found and do still sometimes find their way into iron-built ships, but the danger from this cause seems to be greater when steel is used. It may happen that steel plates as brittle as cast-iron will, unintentionally, be supplied amongst a quantity which are strong and tough. If one only of such brittle plates should pass undetected into the hull of a ship (say—under the engine-room, where plates have been known to crack in a steel-built ship when at sea), it might lead to most serious results, and I think it should be made imperative that not only the manufacturer's name, trade-mark, and place of business, but also the amount of test sustained should be legibly stamped on every portion of metal supplied for shipbuilding.

9. As great strength and the least possible amount of weight are of importance at the upper part of a ship, steel of suitable manufacture, and having a sectional area of from ·7 to ·75 that of iron prescribed for similar service may be used with advantage for sheer strakes, and for decks, stringers, and tie-plates upon the beams. Its use may also be continued with advantage in the construction of masts and yards, which have to bear a strain in a known direction, and in which lightness and strength are required together; but, having regard to the facts which have come to my own knowledge and under my own observation, I should hesitate to recommend, except under carefully considered regulations, its adoption for the entire construction of sea-going ships.

10. At the same time I think it is very desirable that experiments should be made with a view of ascertaining whether, for shipbuilding purposes generally, steel of ordinary or special manufacture and of reduced size and weight will, under every variety of circumstances affecting its use, be as trustworthy, serviceable, and durable as iron of the size and quality now required by Lloyd's rules. It is a subject which, even in a pecuniary point of view, should recommend itself to the attention of shipowners; for if the material be of the increased strength stated, and be in all other respects suitable, there will follow a great diminution of weight and consequently of displacement. This will render it possible for a small ship to carry the same cargo and go at the same speed as a larger one, or the large ship to carry the same cargo and go at the same speed with a greatly reduced power, and a corresponding reduced weight of machinery and reduced expenditure of fuel, oil, and tallow; and thus, in either case, not only will the first cost be considerably less, but there will be a constantly recurring reduction in the current expenses. And if steel machinery and boilers should be substituted for iron, the advantages will be still greater.

11. The popular error amongst those who have not professionally studied or been practically engaged in shipbuilding, of regarding a ship exclusively as a girder, and of supposing that the formula adopted for determining the strength of the latter should be applied unconditionally to the construction of the former, has led to much mischief and many serious mistakes in practice. If a ship were to remain always on shore or even in perfectly still water, the comparison might hold good, but there can be no possible analogy between a girder or beam at rest on shore and a ship in motion in a sea-way. No girder or bridge that has yet been built would stand the test to which a ship of similar proportions and mode of construction would be subjected in a rough sea. The notion that a ship should be of equal strength at top and bottom and be thinned away to the extent proposed at the ends is erroneous, and cannot without disadvantage be practically carried out, and we have very recently had melancholy and convincing proof that the strengthening of the upper part of a ship had better be attained by any of the methods known to practical men than by the introduction of box girders or waterways which have been so persistently advocated. The formula used for bodies in suspension will not apply to bodies in flotation. Here is a simple practical illustration. An outrigger wager skiff 30 ft. long, 10 in. broad, 5 in. deep, not much thicker than a band-box, and weighing 30 lbs., will carry a man six times its weight with a violent motion through the water, at the rate of ten miles an hour; but lift the skiff out of the water, suspend it or support it at both ends, and, if the man keeps his seat, it will break in two. In the case of a beam or girder on shore the weight to be sustained is accurately known beforehand, the load is uniformly distributed, and the strains are constant quantities and gradually applied. But, in a ship, the weight carried is a varying quantity, the load is unevenly distributed, and the strains are not only suddenly applied, but vary in amount and direction every time the ship alters her position, which alteration in position involves also a change in the position of the whole of the material of which the ship is composed. Again, girders and beams are of a recognised and similar form, but the forms of ships have to be adapted to the services on which they are to be employed, and varying according to the tastes and opinions of the owners or builders. A ship, too, in addition to having a form adapted for speed, and having arrangements for cargo, for comfort, and for ventilation, should possess seaworthy properties, should be able to carry her load with an easy motion even under all varieties of trim, and should have the means of releasing herself speedily from any body of water which may be shipped suddenly upon her decks. None of these conditions are required in a shore girder or beam, and a ship can with no more propriety be called a girder than a girder can be called a ship. Let a girder be a girder, and the size and amount of material to be used in its construction with its mode of distribution be made the subject of direct scientific calculation; but let a ship remain a ship and its construction be governed by rules based upon scientific investigation combined with the carefully considered results of every-day experience, and we shall not have to look upon such unserviceable and unprofitable productions as have sometimes come under our notice.

12. I have carefully considered the subject in all its bearings, and have applied to it all the facts relating to steel and steel-built ships which have come within my own knowledge and observation, and I am of opinion that steel of suitable manufacture may be used of less size and weight than iron for the purposes stated in paragraphs numbered 6 and 9 in this paper, and that it may be adopted for the entire construction of sea-going ships as soon as it has been ascertained by carefully and impartially conducted experiments and well directed observations, that, with a reduced size and weight, it possesses all the properties, and will efficiently fulfil all the conditions which, under the existing Regulation of Lloyd's, the Admiralty, and the Liverpool Underwriters are required of the material at present in use. But you have, as members of your institution, representatives of cast, puddled, hematite, Firth's, Bessemer, and Mersey steel, and you have also good practical shipbuilders and eminent engineers,—all of whom will, I hope, take up the points to which I have adverted in this paper, and unreservedly state their opinions and experience upon a subject which is really of great importance to the shipowning, shipbuilding, and engineering interests of this country.

In conclusion, I am aware that I have expressed opinions which are opposed to those now commonly entertained by engineers, but I am, on this account, the more willing to have them submitted to the criticism of the institution, and to abide by its verdict. Dr. Fairbairn, at page 47 of his recent work on iron shipbuilding, tells us positively that "the strains in a ship and a monstrous tubular girder are analogous," but when Mr. Tate comes to the mathematical investigation of the subject, he tells us candidly, at page 276 of the same work, that "the strains on a ship are somewhat different from the strains on an ordinary fixed girder." Here are two opinions of equal value in the same work, and yet it is strange that the former should be readily accepted and constantly, though, perhaps, often inconsiderately repeated, while the latter is left untouched or never acknowledged. Again, in a chapter in the same work, on composite shipbuilding, we are told that "the system is not an eligible one, and for sea-going ships is utterly at variance with sound principles of construction;" that "any combination, however well executed, is not calculated to ensure the requisite strength for sea-going vessels subject to severe strains;" that, "on the contrary, it appears obvious that a vessel constructed with iron frames and wood sheathing is a decidedly weak and unsatisfactory structure;" and that, "for large ships intended to navigate the open sea, the construction cannot be recommended either on the score of economy or safety." These opinions and conclusions are formed upon the results obtained from one miniature experiment which is published in the same chapter. But of what value are either the results of the experiment or the conclusions therefrom, when we find that the wood which we may say is the only wood used for composite ships, and which is in every respect the most suitable for the purpose, was altogether omitted; that the experiment was conducted upon an inappropriate "platform" imperfectly constructed of "red pine;" that the description and woodcut illustrative of this experimental platform prove that its mode of construction was not at all in accordance with that of composite ships, or with the ordinary principles and practice observed in ship-building; that although we are told in sections 3 and 4 that "red deal or pine is the timber chiefly employed," and that "it is probably the best timber for sheathing in combination with iron frames" we know that not only is red deal or pine never used, but that no shipbuilder would ever dream of planking a composite ship with such unsuitable material; that the number of sea-going ships of 2,130 tons and under built on this principle has increased from 3 in 1862 to respectively 9, 18, 40, and 40 in the following years; and that the shipowners who have put the principle to the most severe test, and who ought to be the best judges of the value and suitability of the article on which they depend so much for success, have not only not lost confidence in it, but continue to give orders for the same description of vessel? On the 11th September last I made a careful and searching examination in dry dock of the composite clipper *Ariel*, of 853 tons. This ship was one of the nine engaged in the exciting race home from China. She left Foo-chow-foo with the *Taeping*, another composite clipper, of 767 tons, on the 30th May; lost sight of her opponent for seventy days; then picked her up off the Lizard; and, with every stitch of canvas set, had a neck-and-neck race with her up the channel, both ships arriving in the Thames on the 7th September, after having accomplished a voyage of upwards of 16,000 miles in 99 days. Without going into the details of an examination which was full of interest, I may state that although the ship must have been subjected in the most intensified degree to all the strains which act with the greatest severity upon ships engaged in such a contest, not one of the results or symptoms which would have been expected from a perusal of the chapter above referred to was discovered, and that the ship and every part of her were as firm, sound, and perfect as on the day she left her builder's hands. I have made this digression for the purpose of showing that the statements, opinions, and conclusions of modern writers must not be accepted or acted upon without having been first carefully considered and tested; that the teachings of modern theory and the results of miniature experiments are of little practical value unless they accord with, and are confirmed by, the facts brought to light in every day practice; and that, so long as shipowners remain alive to their interests, and the Committee of Lloyd's Register continue a progressive policy, and an efficient supervision, shipbuilding and its improvement may safely be left in the hands of those engaged in the business, who have a thorough knowledge and experience of the subject, and whose success and reputation wholly depend upon their turning out of hand ships which shall be in every respect sufficient and safe for the legitimate purposes of navigation, and suitable and profitable for the trades or services in which such ships are to be respectively employed.

REVIEWS AND NOTICES OF NEW BOOKS.

The Analysis, Technical Valuation, Purification, and Use of Coal Gas. By the Rev. W. R. Bowditch, M.A., F.C.S., Incumbent of St. Andrew's, Wakefield. (London: E. and F. N. Spon. 1867.)

This work, as the title implies, is rather of an analytical than synthetical

character, inasmuch as it does not deal with the mode of manufacturing coal-gas, but of its chemical properties as a suhstance, and the proper means of utilising it, and deriving from it the largest possible proportion of light. About one-third of the work is devoted to an inquiry into the proper method of testing gas, aud to photomotry—a subject ably and exhaustively treated, and the knowlodge of which seems to form, indeed, the author's *forte*. The quantitative and qualitative analysis of coal-gas also occupios a considerable portion of the volume before us. Tho romainder of the work is filled with miscellaneous data relating to gas purification, gas burning, &c., and some practical hints of quito an original character render it more interesting. The quostion of the origin aud propor means of prevention of gas explosions might, however, have been troated somewhat more *in extenso*. Chapter XIII. contains, indeed, some rather amusing anecdotes about the gnawing of gas-pipes by *rats*, and subsequent explosions; but the author's advice, "to avoid the uso of lead tubes in buildings which are known to be infested with rats," does not by any moans dispose of the subject. On the whole, however, both the student and the gas enginoer might greatly profit by a perusal of Mr. Bowditch's work. We may romark, bosides, that the printing is done in large and very clear type, and the style iu which the book is got up does crodit to tho "enterprise" of the publishors.

Weale's Rudimentary Series.

No. 21. *A Treatise on Rivers and Torrents, with the method of regulating their course and channels.* By PAUL FRISI, F.R.S., &c., Professor at Milan. To which is added an Essay on Navigable Canals. Translated hy Major-General John Garstin, of the Bengal Engineers. A new edition. 1861.

A strictly rudimentary and very primitive treatise. Whether a work, the first edition of which was printed in 1762, should, in 1867, form a part of au educational series, and whether the present state of civil and especially hydraulic engineering, render it advisable to resort to an antiquarian library for instruction on such snhjects,—these are questions decidedly open to controversy. In our opinion, there are authors enough, at tbe present day, capable and willing to write on matters of this kind, in a mode suited to the state existing in the second half of the 19th, not of the 18th century. Tbe reprint of this translation we do not object to by any means, but merely to its incorporation into a series of books designed to instruct the student on the actual, not the past, state of things. In sucb a series Frisi is quite as much out of place as Vitruvius, Pliny, Straho, or Pomponius Mela. Yet, as an historical reminiscence, Frisi's hook is not devoid of interest, and, standing on it own merits, it may repay a perusal.

No. 63.—*Rudimentary Treatise on Agricultural Engineering. With illustrations.* By G. H. ANDREWS, C.E. Three parts in one. 1852 and 53.

This volume has just heen heen re-issued hy Messrs. Virtue Bros. and Co., the transferees of the Weale series. Though somewhat out of date, it still contains a good deal of useful information. The first part is devoted to "buildings," the second to "motive powers and machinery of the steading," the third to "field machines and implements." The author heing himself a practical agricultural engineer of some standing, it is hut natural that he should have treated tbe subject with ability and lucidity. As regards the woodcuts illustrating this volume, they are remarkahly well got up for a work of this kind, comhining usefulness with cheapness and designed to he within the reach of even humble intellects. We hope a further edition will he supplemented by something about the more recent improvements in agricultural engineering, aud chiefly the more extensive adaptation of steam to the cultivation of the soil.

No. 82A.—*A Treatise on Water-works for the supply of Cities and Towns.* By SAMUEL HUGHES, F.G.S., C.E. 1859.

Also a re-issue. To the object it was designed to serve, tbis work is perfectly equal, at least as far to its main portions are concerned. In some parts it is either too scientific or too unscientific. Thus, the mathematical deductions on the flow of water should either have been extended much further and gone into more thoroughly, or else plain rules in words, not formulæ, should have been substituted. Tbis, however, is an objection that does not greatly affect tbe value of the hook. Indeed, tbe very extensive subjcct of water-works could not have been treated morc ably and lucidly in such a small compass as the one to which Mr. Hugbes was compelled to confine himself.

No. 82B.—*Rudimentary Treatise on the Power of Water, as applied to drive Flour Mills, and to give motion to Turbines and other Hydrostatic Engines.* By JOSEPH GLYNN, F.R.S. Second editiou. 1856.

A compilation of considerahle merit. During the whole of the present century, water power has heen kept quite in the hackground hy steam. In this country, at least, very little has been done towards the utilisation of the immense hydraulic moving force, lying dormant in the currents and waterfalls chiefly of the North. We now commence to find out that in many cases, water forms a more advantageous motor than steam, and this advantage is likely to be enhanced hy the advance iu the price of fossile coal. The drawhack cousisting in the irregularity and unreliability of the snpply of water is greatly reduced by the use of horizontal water-wheels, and upon the latter greater attention has heen hestowed in Mr. Glyun's than in most previous works of tbis kind. This and other cognate subjects are treated intelligibly, and though tbe reader may not, from the descriptions given, learn how to construct any of the hydraulic engines, he will certainly be led to hetter understand their naturc and the principles they are based upon.

NOTICES TO CORRESPONDENTS.

J. D. C.—The following is a list of the railway guages in use in the most important countries of Europe, Asia, and America, viz.:—

Europe.—Standard guage of 4ft. 8½in. in Great Britain generally, France, Germany, Austria, Switzerland, Scandinavia, Belgium, Holland, and Prussia.
6ft. in Spain. 5ft. 3in. in Ireland.
"Broad guage" of 7ft. 0¼in. on Great Western Railway (England.)
Asia.—5ft. 6in. in India.
(For all these gauges see Molesworth's pocket-book.)
America.—4ft. 8½in. in the United States generally.
6ft. on the New York and Erie Railway and adjoining lines.
5ft. 3in. in Canada.

For the latter see Stevenson's "Civil Engineering in North America." Other guages have been and are still in use in several countries, hut for the continual traffic the 4ft. 8½in. guage is generally obtaining at the present day. The guage of 1 metre 60 centimetres (or 5ft. 3in. English) originally introduced in the Grand Duchy of Baden, was abandoned about 1854. The broad guage of the Great Western and Metropolitan Railways is the only one worth mentioning. For small lines, not intended to he worked in connection with tbe railway net of the respective country, the standard guage is not always adhered to.

DENS.—On the various modes of coupling gearings for screw-cutting lathes, hased upon the metrical system, you will find ample information in a paper entitled "Notice sur le tour à fileter," by Mr. Jouvet, in the annual for 1863 of the "Société des anciens élèves des Ecoles Impériales d'arts et métiers." (Paris, Eugène Lacroix, 1863.)

A. R.—The increase in the diameter of one of the journals of the cross-head does not affect the working of the machine in the least, so long as the length of both connecting rods, from centre of crank pin to the horizontal axis of cross head, remains identical. It is well understood, that the brasses on the journals must be accurately fitted.

PRICES CURRENT OF THE LONDON METAL MARKET.

	Jan. 26.			Feb. 2.			Feb. 9.			Feb. 16.			Feb. 23.		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, seleeted, per ton ...	89	0	0	89	0	0	85	0	0	85	0	0	84	0	0
Tough eake, do.	86	0	0	86	0	0	83	0	0	83	0	0	81	0	0
Copper wire, per lb.	0	1	0½	0	1	0½	0	1	0½	0	1	0½	0	1	0½
„ tubes, do.	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0
Sheathing, per ton	91	0	0	91	0	0	87	0	0	87	0	0	85	0	0
Bottoms, do.	96	0	0	96	0	0	96	0	0	96	0	0	91	0	0
IRON.															
Bars, Welsh, in London, per ton	6	7	6	6	7	6	6	7	6	6	7	6	6	7	6
Nail rods, do.	7	0	0	7	0	0	7	0	0	7	0	0	7	0	0
„ Stafford in Londou, do.	7	15	0	7	15	0	7	15	0	7	15	0	7	15	0
Bars, do.	7	15	0	7	15	0	7	15	0	7	15	0	7	15	0
Hoops, do.	8	15	0	8	15	0	8	15	0	8	15	0	8	15	0
Sheets, single, do.	9	10	0	9	10	0	9	10	0	9	10	0	9	10	0
Pig, No. 1, in Wales, do. ...	4	5	0	4	5	0	4	5	0	4	5	0	4	5	0
„ in Clyde, do. ...	2	15	0	2	15	6	2	14	9	2	14	9	2	14	6
LEAD.															
English pig, ord. soft, per ton	20	5	0	20	5	0	20	0	0	20	0	0	19	10	0
„ sbeet, do. ...	21	0	0	21	0	0	20	10	0	20	10	0	20	10	0
„ red lead, do. ...	21	10	0	21	10	0	21	5	0	21	5	0	21	5	0
„ white, do. ...	27	0	0	27	0	0	27	0	0	27	0	0	27	0	0
Spanish, do.	19	10	0	19	10	0	19	0	0	19	0	0	19	0	0
BRASS.															
Sheets, per lb.	0	0	10	0	0	10	0	0	10	0	0	10	0	0	10
Wire, do.	0	0	9	0	0	9	0	0	9	0	0	9	0	0	9
Tubes, do.	0	0	11	0	0	11	0	0	11	0	0	11	0	0	11
FOREIGN STEEL.															
Swedish, in kegs (rolled) ...	14	0	0	14	0	0	14	0	0	14	0	0	14	0	0
„ (hammered)	16	0	0	16	0	0	16	0	0	16	0	0	16	0	0
English, Spring	19	0	0	19	0	0	19	0	0	19	0	0	19	0	0
Quicksilver, per bottle ...	6	17	0	6	18	0	6	17	0	6	17	0	6	17	0
TIN PLATES.															
IC Charcoal, 1st qu., per box	1	12	0	1	12	0	1	12	0	1	12	0	1	12	0
IX „ „ „	1	18	0	1	18	0	1	18	0	1	18	0	1	18	0
IC „ 2nd qua., „	1	8	0	1	8	0	1	8	0	1	8	0	1	8	0
IC Coke, per box	1	4	6	1	4	6	1	4	6	1	4	6	1	4	6
IX „ „	1	10	6	1	10	6	1	10	6	1	10	6	1	10	6

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Pyper v. the Hammersmith Railway Company.—This was an action to recover compensation in damages for injury to the plaintiff's property from the construction of the Hammersmith Railway. There was a viaduct constructed by the Company, on which the trains ran close to the plaintiff's premises, whereby it was alleged the property had been "injuriously affected" in various ways, and for this (no part of the premises being actually taken) he claimed compensation. When the line was opened, and the trains began to run, there was a sensible vibration caused to the house, and this was a main item in the claim. The jury gave the plaintiff compensation, upon which the Company proceeded to upset the verdict, on the ground that the property in question had not been "injuriously affected" by the execution of the works within the meaning of the 68th section of the Lands Clauses Act. The Court of Queen's Bench decided against the plaintiff, and in favour of the defendants. The plaintiff then appealed to the Court of Error, and the latter reversed the decision of the Court of Queen's Bench, and gave it in favour of the plaintiff.

The Rights of Railway Debenture Holders.—Gardner, Drawbridge, et al. v. the London, Chatham, and Dover Railway Company.—The London, Chatham, and Dover Railway Company having been unable, for some time past, to meet their engagements, the plaintiffs had obtained from Vice-Chancellor Stuart an order vesting the entire concern in the hands of managers and receivers appointed by and acting under the orders of the Court of Chancery, by whom all the business of the Company was to be conducted, and into whose hands all the revenues were to be paid. The Company was directed to pay into the hands of these receivers, as trustees for the plaintiffs and other debenture holders, the monies received for the re-sale of surplus lands, which the Company had purchased for its numerous and expensive lines; and the interim rents of these lands were declared subject to the same trusts. Thus, the debenture holders obtained a substantial security for their arrears of interest. From this decision the Company appealed, and on January 26th Sir Hugh Cairns, on behalf of the Lords Justices of Appeal in Chancery, delivered final judgment. The first part of the Vice-Chancellor's decision, by which official receivers were appointed, was reversed, upon the ground that, were the Court to assume the responsibility of the management of a mismanaged concern, it would make itself answerable for all that was done or omitted to be done on a line whose business was hopelessly involved. The second part, consisting in the order of Nov. 20th, directing the sale monies of surplus lands to be paid to the receiver on behalf of the debenture holders, was likewise reversed by the addition of the clause: "This order is not to extend to any rents or sale monies arising from surplus lands of the company." From this decision it may be inferred that, according to the present state of the law, debenture holders are placed in a position analogous to that of holders of preference stock, *i.e.*, that their real security lies in the traffic or revenue profit of the railway as a "going concern," not in the materials and property of which that undertaking is composed.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

The Contract for Works at Chatham Dockyard.—The contract has been signed at the Admiralty for the construction of the basins, docks, factories, and other works connected with the intended enlargement of Chatham dockyard. The estimated outlay is a million and a quarter sterling. Although several of the most eminent of the railway, engineering, and other firms in England were invited to give in tenders for the execution of the works, they either shrank from the undertaking, or tendered on terms which the Admiralty deemed to be inadmissible, and the contract has accordingly passed into the hands of Mr. Gabrielli. The works will be commenced in a few weeks, when 2,000 hands will be taken on in the first instance for the preliminary excavating operations.

Railways in Spain.—The nominal share capital of the various Spanish railway companies, including the company for the canalisation of the Ebro, is shown by an official return to have amounted, at the close of 1865, to £29,786,074. The total subventions accorded to the same date were £17,564,666. The actual amount of capital paid up on the shares was, however, only £25,842,339, and the actual amount of the subventions paid by the Government was only £11,648,320. The actual amount received from 2,872,285 obligations negotiated (of which 49,405 had been redeemed) was £23,257,651. The actual amount of capital collected at the close of 1865 for railway purposes in Spain, from all sources—shares, subventions, and obligations,—was thus £65,748,310.

Petroleum in the United States.—The petroleum trade which is now chiefly confined to the wells in Pensylvania, was scarcely remunerative during the past year, the price of oil being very low on account of the supply exceeding the demand. The production for 1866 is estimated at 2,850,000 barrels of refined oil, of which 1,489,000 barrels were exported, and the balance was either consumed or is still stored at home. The supply still on hand in home and foreign markets, is estimated at 733,000 barrels,—a fact which shows that the market is glutted, an amount equal to one-third the entire consumption of 1866 being still on hand. The exportation of petroleum, in 1866, was more than that in 1865. In the oil region it is announced that the producers are endeavouring to make some arrangements by stopping up wells, and otherwise to reduce the excessive supply, in order to put the price up to a remunerative figure. Their success in this is somewhat questionable, however. The Sheriff of Venargo county, Pennsylvania, announces that he will sell at public auction, for unpaid taxes, the lands of nearly fifty joint-stock petroleum companies which have become bankrupt.

Pearl Fishing.—According to accounts from Panama, an undertaking has recently been organised in New York, called the Pacific Pearl Company. This company intend to operate at the Pearl Islands, about thirty miles from Panama. A submarine boat has arrived, capable of carrying ten or twelve men at one time, who can work under the water for many hours, and so constructed that it can be lowered or hoisted at a moment's notice, and so arranged that when lowered they can open the boat at the bottom, by means of two trap-doors, allowing a space of 10ft. square in each, for working purposes. It is thought that by this time the company have commenced their operations.

Weights and Measures in Poland.—A new ukase abolishes, from the date of April 17th, in the kingdom of Poland, the use of Polish weights and measures, and replaces them by Russian.

Iron Trade in Scotland.—According to the ironmasters' returns, just made, the quantity of pig-iron produced in 1866 in Scotland, was 984,000 tons, showing the striking decrease of 170,000 tons as compared with the previous year. The deliveries per railway, and shipments foreign and coast-wise, combined with the local consumption, were 1,136,000 tons, and show a falling off, when compared with the preceding year, of 136,000 tons. As certified by the committee appointed by the trade, the stock of pig-iron is now 510,000 tons, thus exhibiting the marked decrease of 142,000 tons as contrasted with 1865. During the year the price has fluctuated from 82s.—the highest point reached in April,—to 51s., the lowest to which it fell, in May, averaging 60s. 6d. per ton, against 54s. 9d. per ton in the previous year. The malleable iron-works, the foundries, the ship-building yards, have felt the languor of the depressing influences which generally prevail.

The Suez Canal.—From Cairo we hear that two large steam tugs have passed through the fresh water canal and arrived safely at Suez. The *Isthme de Suez* states that M. Dassaud, the contractor, has signed an agreement with the Viceroy to construct two ports, one military and the other commercial. They will be separated by an immense jetty, traversed by a railway. The works will cost £600,000, and take six years to complete.

Cotton in India.—In the last five past years the following has been the area cultivated with cotton, and the estimated out-turn in maunds of 80lbs.:—

Crops of	Acres.	Maunds.	Crops of	Acres.	Maunds.
1861	953,076	1,199,750	1864	1,730,634	1,957,738
1862	985,578	1,057,735	1865	895,102	824,540
1863	1,135,688	1,122,051	1866	1,112,677	1,059,962

Roughly, the fact may be relied on that 1865 saw the cotton crop of the north-west reach its lowest point under the panic and ruin caused by the unexpected termination of the American war, and that the past year has been a recovery. But as the actual out-turn of cleaned cotton in 1865-66 was only 793,291, while the estimate was 824,530 maunds. It cannot be assumed that the recovery has been so great as the figures for 1866 represent. The crop is represented as favourable, and an "abundant yield" is expected if there is good weather for the picking. The wholesale prices at Agra have ranged from 17 rupees a maund, at the end of October, 1865, to 18 rupees in September last. (1 rupee = 1s. 10½d.) The prospects for the present year are stated to be favourable.

NAVAL ENGINEERING.

Beaching the "Great Eastern."—The projected duty of the *Great Eastern* for the ensuing summer—that of conveying passengers from New York to the Paris Exhibition—having rendered a thorough overhauling and refitting necessary, it was decided to place her on a gridiron specially constructed for her on the foreshore about 200 yards south of New Ferry, on the Cheshire side of the Mersey river. This gridiron is placed about one-third of the distance between low-water mark of spring tides and the high-water mark, and is about 400ft. long by 60ft. broad, resting on a firm bed of clay and shingle. The first and only attempt of placing the vessel on the frams was made with the morning tide on January 13th, and indeed she glided very quietly and easily to her resting place. The *Great Eastern* moved from her moorings shortly after 9 o'clock, drawing 18ft. 6in. of water. She was propelled by her screw, and was assisted by a tug or two. The tide was at its height at 10.20, and registered 18ft. 1in. Capt. Sir James Anderson commanded. She was put side on, and came smoothly and easily to the bed prepared for her without a single hitch. She was favoured by smooth water. She was at once secured in her position by powerful anchors and chain cables, and in the early afternoon was high and dry. The long, low line of beach had the effect of making her appear much shorter and altogether smaller than she is. On getting underneath her, however, her vast size was at once apparent. For 18ft. or 20ft. her plates were covered with a peculiar kind of grey weed, like coarse hair. Myriads of mussels and barnacles were housed among this weed, and though her bottom is much cleaner than was expected, it will take much labour to thoroughly clean the vast surface. Her screw appears to be very small in proportion to her size. According to the latest news, the *Great Eastern* is to leave England for America on the 20th March. The intermediate shaft of the paddle engines has been condemned, and Messrs. G. Forrester & Co. are to put in a new one, which is being forged by the Mersey Steel and Iron Company, and was to be finished by February 12th. Six new screw engine boilers are also being supplied. The "big ship," when she again leaves the Mersey, will have accommodation for no less than 2,800 passengers.

The "Himalaya," screw troopship made a trial of her machinery and speed at the measured mile in Stokes Bay, on January 16th, on the completion of her repairs, alterations, and refit for further troop service on re-commission. Commander Wells, H.M.S. *Asia*, was in charge of the ship. Six runs were made over the measured mile with the ship drawing 18ft. 1in. of water forward and 20ft. aft., the mean speed of the ship being 13·637 knots. A full circle was turned to port in 9 min. 3 sec., and to starboard in 9 min. 32 sec. The machinery worked very satisfactorily, and after the trial the *Himalaya* returned to harbour to complete the necessary measures for immediate commission.

The "Urgent," screw troopship, Capt. G. H. Henderson, 1,981 tons, 400 nominal horse-power of engines (the engines by Maudslay and Field, and the boilers and condensers new on the present trial, and received and supplied from the steam factory department of this dockyard), made her official trial of speed over the measured mile in Stokes Bay, on January 19th, preparatory to sailing for China and Japan. Commander John C. Wells, of H.M. ship *Asia*, was in command of the *Urgent*. The wind was at a force of 4, but off the land at N.E., and giving thus smooth water over the mile. The ship drew 18ft. 10in. of water forward, and 20ft. 1in. aft; had six months' stores on board, 360 tons of coals, and was complete in every respect for sea. The speed trial of the ship was made with full power only, which gave the following figures:—first run, 13·091 knots; second run, 11·920 knots; third run, 13·900 knots; fourth run, 14·285 knots; fifth run, 14·285 knots; sixth run, 10·975 knots. These returns give the *Urgent* the average speed over the mile of 12·713 knots. The pressure of steam was steady, only ranging from 20 to 20½lbs., the vacuum was 22½in., and the revolutions of the engines had a minimum rate of 14, and a maximum of 65.

SHIPBUILDING.

LAUNCH AT WHITEHAVEN.—On Jan. 19th, a very successful launch took place from the shipbuilding yard of Messrs. Joseph Shepherd and Co. The vessel launched was the brig *Ann Middleton*, owned by Mr. Thomas Middleton, and is a beautiful specimen of the class, having in addition to her brig rig, double topsail yards. Her length is 97ft. 6in.; breadth, 22ft. 7¾ins.; depth, 12ft. 10⅝ins.; register, 228 9-94ths. The command of the vessel will be taken by Capt. Mossop, and she is most likely to be engaged in trading to the Mediterranean, West Indies, and Brazil.

LAUNCH AT PRESTON.—The S.S. *Pantheon* was launched on Thursday, the 5th Feb., from the shipbuilding yard of the Preston Iron Shipbuilding Company, by whom she has been built for Messrs. T. and J. Harrison, for their Liverpool and New Orleans line. The length on water line of the *Pantheon* is 206ft., beam 27ft. 6in., depth of hold 16ft., depth to spar deck 24ft. Tonnage O.M. 7 0. Gross register about 920 tons. She is brigantine rigged, with iron lower masts, &c. Engines, direct acting, 100 nominal, by Forrester and Co., Vauxhall, Tomlay, Liverpool. The *Pantheon* is, we understand, the last vessel that will be built by the present company, but it is expected a new shipbuilding company may be formed in Preston, should the trade increase.

THE "ARCTIC," screw whaling vessel, was launched from the building yard of Messrs. A. Stephen and Son, Dundee, on February 7th; tonnage 652 tons builders' measurement, engines 75 horse-power. To be dispatched to the early sea-fishing in March, afterwards to the Davis' Straits whale fishery.

THE "ABER," steam tug, was launched on February 13th, from Messrs. W. Nicholson and Sons' shipbuilding yard, Southwick. Length 110ft., beam 21ft., depth 10ft. 6in.; tonnage 165 tons N.N.M.; built of wood, but strapped with diagonal iron plates; 75 horse-power engines, also by the builders; cylinders, 33½in. diameter.

LAUNCH OF THE "GAEL."—This paddle steamer, built by Messrs. Robertson and Co., was launched on the Clyde, on February 11th. Her dimensions are as follows:—Length of keel and forerake, 210; breadth of beam, moulded, 23ft.; depth, moulded, 11ft.; tonnage, old measurement, 550 tons. The *Gael* is to be propelled by a pair of oscillating engines of 150 horse-power, by Messrs. Rankin and Blackmore, with feathering paddle wheels, expansion valves, steam winch, &c. She is intended for the Campbeltown and Glasgow Steam Packet Company, to trade between Campbeltown, Greenock, and Glasgow.

IRON-CLADS FOR JAPAN.—The first of a number of armour-plated frigates for the Japanese Government has just been finished at the Seyne building-yards, near Toulon. It is called the *Taïcoun*, and will cost three million and a half francs. By special permission of the Minister of Marine, six guns—250 to 450 pounders, and costing each 60,000 francs—are comprised in the amount of the contract.

SHIPBUILDING ON THE CLYDE.—Messrs. Caird and Co. have launched a screw of about 3,000 tons, builder's measurement, named the *Cymbria*. She is a sister vessel to the *Hammonia*, recently launched by the same builders for the Hamburg American Steam Packet Company. The engines of the *Cymbria* will be of 500 horse-power, and will be supplied by Messrs. Caird and Co.—The Dublin and Glasgow Company's new steamer, *Earl of Dublin*, has made a satisfactory trial trip, "having run the lights" at the of rate 18¾ miles per hour. The *Earl of Dublin* was built by Messrs. R. Duncan and Co., of Port Glasgow, and was engined by Messrs. Rankine and Blackmore, of Greenock. The dimensions are:—length, 254ft.; breadth, 27ft.; depth of hold, 15ft. Her burthen is 925 tons, builder's measurement, and she is propelled by a pair of oscillating engines of 350 horse-power with feathering floats. Her cylinders are 63ins. diameter, with 7ft. stroke, fitted with link motion, and Rankine and Blackmore's new expansion valves.—Messrs. R. Steele and Co., of Greenock, have contracted to build a composite ship of 1,250 tons for Capt. T. Hamilton, Greenock. Altogether trade prospects are considered to be looking favourable at Greenock.

STEAM SHIPPING.

CALIFORNIA AND CHINA MAIL.—The direct steam communication between the Pacific coast of the United States and China and Japan was inaugurated on January 1st, by the sailing of the pioneer steamer of the line, the *Colorado*, from San Francisco. This, the first attempt of American trans-Pacific navigation, is made by the Pacific Mail Steamship Company, which receives an annual subsidy of 500,000 dollars from the Federal Government on condition that the Company's steamers touch at Honolulu; to do this, a delay of five days in each trip is involved. She capital of the P.M.C. is 20,000,000 dollars, and the steamers already running are some twenty in number. The new line will command six steamers, each of 5,000 tons, and costing 1,000,000 dollars. The sum of 500,000 dollars has already been expended by the Company in San Francisco alone for the construction of wharves and storehouses. The *Colorado* took out 250 passengers, 682,287 dollars in treasure, and freight of the value of 25,000 dollsrs. The success of this line will be greatly enhanced by the forthcoming completion of the direct railway connection between the Atlantic and Pacific Oceans.

MILITARY ENGINEERING.

FOUR YEARS' CONSUMPTION OF FIELD MATERIAL.—During the late civil war in the United States, the Federal Ordnance Bureau furnished the Federal army with 7,892 cannon, 11,787 artillery carriages, 6,333,298 artillery projectiles (shot and shell), 6,539,999 rounds of grape and canister shot, 2,862,177 rounds of fixed artillery ammunition, 3,477,655 small arms, muskets, rifles, &c.; 544,475 swords, sabres, and lances; 2,146,175 complete sets of artillery accoutrements, 216,371 sets of cavalry accoutrements, 539,544 complete sets of horse equipments, 228,164 sets of two-horse artillery harness, 732,526 horse blankets, 1,622,176,474 cartridges for small arms, 1,220,535,435 percussion caps for small arms, 10,281,305 cannon primers, 4,226,377 fuses for shell, 2,440,054 pounds of gunpowder, 6,395,152 pounds of nitre, 90,416,295 pounds of lead in pigs and bullets, besides other articles in enormous quantity.

FORTIFICATIONS IN THE UNITED STATES.—The estimates of the Engineer Department of the appropriations necessary for the repair, maintenance, and completion of the various Government fortifications in the state of New York for the current year amount to more than 1,200,000 dollars They include 120,000 dollars for Fort Schuyler, New York harbour; 100,000 dollars for a fort at Willet's Point, New York harbour; 80,000 dollars for a new battery near Fort Hamilton, New York harbour; 100,000 dollars for a sea wall at Governor's Island; 150,000 dollars for a fort at Sandy Hook.

THE NORTH GERMAN ARMY.—It is expected that by the beginning of May the whole of the North German troops will be armed with breech-loaders. With equal zeal, the new cast steel 4-pounders are being manufactured in the foundries. At Krupp's, Essen, no less than 2,370 cast steel cannon have been ordered by the Prussian and other governments.

RAILWAYS.

GREAT NORTHERN RAILWAY.—The works on this company's line from Doncaster to Gainsborough are in a forward state, and it is expected that it will be ready for opening on the 1st of March next. When completed, the whole of the coal traffic between Doncaster and London will pass over the new line *viâ* Lincoln and Peterborough.

THE LAKE DISTRICT RAILWAYS.—A movement is in operation to secure a connection between the Lake District Railway and the Midland Railway system. By this means a short and easy route would be afforded to the inhabitants of Leeds, Hull, Bradford, Sheffield, Halifax, Huddersfield, and the manufacturing districts of Yorkshire for visiting the lake districts of Cumberland, as well as supplying a direct transit for the goods manufactured in these places, and also giving another line of communication between England and Scotland.

ACCIDENTS.

ON THE GREAT NORTHERN RAILWAY a singular accident occurred on February 4th, at a short distance south of Grantham station; by it the lives of a large number of passengers were placed in imminent peril. It appears that the down express leaving King's-cross at 5 p.m., journeyed safely until leaving Peterborough, which place it left at 6·50, drawn by a couple of powerful engines, and all went well until just after crossing a small bridge over the River Witham, at about a mile from Grantham, when the drivers, guards, and passengers became alarmed by the sudden oscillation of the engines and carriages. The breaks were put on with all possible speed, and having proceeded another three hundred yards it was brought to a stand, when it was found that the tender of one engine had left the rails, yet none of the carriages had been dragged off the road, although from the hurrying which ensued the greatest alarm prevailed among the passengers, who, however, sustained little or no serious injury. Several were bruised and shaken, but none so much so as to render their removal from the carriages necessary.

A GOODS TRAIN which was running from SWANSEA to PONTYPOOL, on the Great Western Railway, lately met with a strange and serious accident. Near the Quaker's-yard Junction there is a blind siding, and the man whose duty it was to lock the points, left an aperture of about half-an-inch. As the engine came along, the great wheel got into this aperture, but in passing broke the pivot of the point; the points at once partially closed, and the goods' trucks were sent along the main line. Being prevented from following the locomotive, and thrown into the right track, they exercised a resisting power on the engine which was thrown on its side, and the engine driver and the stoker were killed instantly by the engine falling on them. The whole affair occupied but a few minutes,—in fact, the unfortunate men were killed almost before they knew that an accident had happened.

AT SHEFFIELD, in the night of Jan. 2-3, a boiler explosion occurred at the large forge and rolling mills belonging to Messrs. T. Charles and Son, resulting in the death of the fireman and dangerous injuries to two others. The explosion is believed to have been caused by an insufficient supply of water. The boiler was one of the newest on the premises, and only a short time before had undergone a thorough inspection. At the time of the explosion the whole of the rolls were at work, and the fireman was in the coaling place, and it is believed was in the act of feeding the boiler. Suddenly, and without a moment's warning, a terrific explosion occurred, and the terrified workmen, as they rushed away to the gates of the mill, saw the body of the fireman blown up high into the air, and then fall a considerable distance from the boiler. As soon as the boiler room could be approached, it was discovered that the steam flue had collapsed, and that the boiler had forced itself several feet out of its bed of brickwork. Portions of the boiler-house were blown away, and a man who at the time of the explosion was working about thirty yards off, received some severe contusions by some of the bricks as they were blown away from the building. Another man was also very much scalded, and several others received injuries. The fireman died on the following morning.

AT STOKE CANON, near Exeter, a boiler explosion, accompanied by loss of life, occurred in the paper mills of Messrs. Dewdney, on Jan. 30. In these mills were three "elephant boilers" contiguous to each other. The boilers were about 20ft. long, and 20 horse-power. Since the cold weather set in the boilers had never been worked at full power, but were kept at about 45lbs. to the square inch. About half-past one o'clock, during the dinner hour, one of the boilers burst through two brick walls, and finally lodged on one of the machines. The brickwork and windows of the rooms over were blown out, and great damage done to the building. Two girls standing in front of the boiler were killed, and two others narrowly escaped with their lives. The cause of the explosion is unknown. The boiler was cleaned and inspected about a fortnight before.

TELEGRAPHIC ENGINEERING.

WORKING FIRE-ALARMS IN NEW YORK.—The telegraphic system for working the fire-alarms in New York is as follows:—The city is divided into districts, each district being numbered, and the apparatus is worked thus—If a fire is discovered in any one of the districts, a rush is made to the nearest signal box. In the latter is found a crank in connection with two signal wires extending to the central office, and which, on being touched, communicates to that office the number of the fire district and the fire station. This being done, the alarm is given to the public. From the head office extend a number of wires, used only for the fire alarm bells throughout the city, which are connected with striking machinery liberated by the telegraph; the several alarm circuits are immediately thrown into simultaneous action, and the whole of the alarm bells strike the number of the district where the fire has originated. The operator at the central office now taps on a little transmitting key the number of the station. While the pointer rests upon the district number, the little bell in each signal box strikes the number of the nearest station. The fireman listens to the public alarms and finds from them that the fire is in (say) District 6; he then runs to the nearest signal box and, by listening a moment, finds also the station number from the sounding of a little bell. He now knows that the fire is in District 6 and (say) Station 8, and proceeds with his engine in that direction.—*E. C. Cracknell's Report.*

MINES, METALLURGY, &c.

IMPROVED BLASTING POWDER.—Messrs. Schäffer and Budenberg, of Buckau, are erecting extensive works in Belgium, for the manufacture of their blasting powder, which, it is claimed, can be used for blasting the coal in collieries without any danger of igniting the explosive gases, the whole charge being entirely burnt in the bore-hole, and neither flame nor stones being projected. Experiments made in the Roundwood Tunnel, near Dublin, are reported to have been very successful, a gain of some 60 or 70 per cent. of work arising from the use of that powder as compared with those previously in use.

REMOVAL OF FIRE-DAMP FROM MINES,—A Mr. Williams, from Blairfin, Wales, has been illustrating at Barnsley gas works, a scheme by which, he states, coal mines may be cleared of fire-damp. The desired result is proposed to be obtained by the use of an apparatus consisting of an inverted syphon, to which is connected a pipe from the mouth of the shaft. The short end of the syphon is inserted in the place containing inflammable gas, and the pipe from the top is attached to the other end. The air first being extracted from the pipe, the gas, which is lighter than the atmosphere, will rise to the top. The experiments were, it is said, successful, and were witnessed by several mining engineers.—*Builder.*

GAS SUPPLY.

GAS FROM SAWDUST.—For some time past the town of Coburg, Canada West, has been lighted up with gas prepared according to Ensley's patent process. This gas is made from pine wood and bones, or any other vegetable or animal refuse matter, and since its introduction the lessees of the Coburg Gas Works have reduced its price 1 dollar per 1,000f'. The *Toronto Globe*, from which this statement is taken, does not tell us, however, *to* what price they have reduced it. It only says that sawdust gas can be sold much cheaper than coal gas, and works be erected at much less cost, and that consequently it is especially adapted to small towns.

GAS IN PARIS.—The Paris Company for lighting and heating by gas appears to have made an excellent year's work in 1866. Thus, the receipts in that year amounted to £1,210,005, as compared with £1,133,967 in 1865, showing an increase of £76,038, or 6·71 per cent.

LIST OF APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF "THE ARTIZAN."

DATED JANUARY 3rd, 1867.

22 W. Knaggs—Evaporating and boiling saccharine liquors
23 C. Corroy, G. E. Pnio, and J. Kull—A new specimen of oil for lighting by the use of purified resin oil combined with petroleum, &c.

DATED JANUARY 4th, 1867.

24 G. Haseltine—Improvements in cartridges
25 J. Wilkins—Mould for making cigarettes
26 F. R. Aikman—Instruction of soldiers in the art of shooting over long ranges in a comparatively small space, &c.
27 J. Lane—Heating water and delivering water to steam boilers
28 P. Dagnall—Breech-loading firearms
29 C. I'Anson and A. Kitching—Locking the levers for working railway switches and signals
30 E. N. Gregory—Paper making machinery
31 J. H. Schricht—Action of upright pianofortes
32 J. Bird—Artificial fuel

DATED JANUARY 5th, 1867.

33 D. Dowling and C. Greves—Breech loading firearms
34 G. Logan—Working punkahs
35 E. A. Cowper—Jackets for steam engines
36 E. K. Dutton—Water delivery nozzles employed in the extinction of fire
37 C. Preston, W. Houghton, and R. Bottomley—Mules and like machines for twisting cotton and other fibrous materials
38 I. W. Lamb—Knitting machines

DATED JANUARY 7th, 1866.

39 B. Biggs—Candles
40 C. J. Pownall—Prevention of accidents in pits and mines from the effects of choke damp, &c.
41 C. Kelly—Harmoniums and organs
42 J. Vila y Jové—Improved motive power
43 F. B. Doering—Engines for boring and working rock and other material, &c.
44 W. E. Newton—Facilitating the removal of the bark from oak and other woods
45 R. H. Ashton—Production of printing and embossing surfaces from photographs
46 W. E. Newton—Improvements in augers
47 W. Wny—Preparing phosphatic minerals for use as manure
48 C. F. Claus—Mode of raising brine in or from boreholes of great depth

DATED JANUARY 8th, 1867.

49 J. Stanton—Self-acting safety gun lock
50 W. Martin—Stalls and boxes of treadwheel and crank sheds, &c.
51 R. Robinson—Regulating, controlling, and varying the speed of shafts and machinery
52 E. C. Prentice—Encasing cartridges and other articles liable to injury by damp
53 W. Wood—Jacquard tapestry, &c.
54 J. H. Johnson—Manufacturing and refining sugar
55 W. E. Newton—Treatment of diseases

DATED JANUARY 9th, 1867.

56 W. J. Murphy—Guns or cannon, &c.
57 R. Winder—Packeting hops
58 W. T. Sugg—Valves, &c.
59 J. H. Burton—Breech-loading firearms
60 H. Doulton—Pottery kilns
61 J. Petrie—Steam engines
62 J. H. Hetherington—Preparing cotton, &c., for spinning
63 A. V. Newton—Artificial legs

DATED JANUARY 10th, 1867.

64 L. Hand—Refining and making benzole and other hydrocarbon liquids non-explosive, &c.
65 G. Inderwick—Tobacco pouches
66 A. Foucaut—Waterproof and other articles of wearing apparel
67 W. Robins—Firearms and ordnance, and cartridges for the same

DATED JANUARY 11th, 1867.

68 J. Silvester—Weighing machines
69 E. T. Hughes—Improved differential pump
70 E. M. Chaffee—Elliptic or other elastic springs
71 A. G. Morvan—Making photographic transfers
72 S. P. Widnall—Improved bench
73 F. J. Evans—Illuminating gas
74 J. Darling—Penholders, &c.
75 J. Keudrick—Furnaces and fire bars for the same
76 J. Howard and E. T. Bousfield—Tubular steam boilers
77 M. Henry—Manufacturing buttons, &c.
78 M. H. Simpson—Construction of ships
79 H. Buss—Constructing quays, &c.
80 J. Tomlinson—Bakers' and other ovens, &c.

DATED JANUARY 12th, 1867.

81 J. Hoadly—Preventing wind, &c., from passing under doors and similar places
82 J. Webster, E. Deane, and W. Rumble—Metallic zinc paint
83 C. de Bergue—Instruments for use in packing permanent way
84 J. H. Johnson—Railings or fences
85 H. D. P. Cunningham—Ammunition holders and carriages for the same
86 W. E. Gedge—Dressing and finishing cloth

DATED JANUARY 14th, 1867.

87 W. G. Blagden—Separating silver from lead
88 R. Mushet—Cast steel
89 W. S. Mappin—Breech loading firearms and cartridges for the same
90 F. Brampton—Improved compound for binding books, &c.
91 J. Reilly—Repairing highways
92 C. J. Pownall—Converting snow, &c., into water
93 W. E. Newton—Looms for knitting
94 A. H. Brandon—Carriage lifting jack
95 R. Atkin—Construction of ships, &c.
96 G. Haseltine—Lubricating carriage axles
97 G. Haseltine—Felting hat bodies
98 S. de Wylde—Probing for projectiles
99 W. Clark—Pipe moulding, &c.
100 W. Clark—Rotary engines

DATED JANUARY 15th, 1867.

101 J. M. Hocking—Condensing smoke and vapours
102 H. A. Bonneville—Small arms
103 H. A. Bonneville—Sewing machines
104 E. B. Taylor and F. Winter—Fire screens, &c.
105 M. Henry—Means whereby tools, &c., may be worked at various parts of articles to be operated on by the same
106 A. J. Cooley—Manufacture and preparation of dry tictorial compounds capable of easy solution in water
107 A. Hill—Reaping and mowing machines
108 J. J. E. Robert-Houdin—Clocks

DATED JANUARY 16th, 1867.

109 J. Colville—Meters for gas and liquids
110 W. A. Lyttle—Folding newspapers, &c.
111 J. Clayton—Vertical furnaces for melting and refining metals
112 C. W. Lancaster—Breech loading firearms
113 J. Craven—Fringing shawls, &c.
114 G. Hookham—Firearms and ordnance, and cartridges to be used therewith
115 J. Davies—Permanent way of railways

DATED JANUARY 17th, 1867.

116 W. Howarth, M. Pearson, and J. Pearson—Jacquard engines
117 R. James—Ventilating mines
118 W. Stafford and W. P. McCallum—Bolt
119 E. Suvern—Method to purify the dirty water flowing from sugar factories
120 C. G. Buxton—Hydrostatic engine
121 W. E. Newton—Tinting the surface of paper
122 R. Newhall—Cases for needles
123 D. Barker—Moulding coal and other substances for the formation of artificial fuel, &c.
124 H. Starr—Safety match box

DATED JANUARY 18th, 1867.

125 C. F. Cooke and J. Standfield—Combinations and arrangements of differential wheel gearing
126 A. Bereus—Filling splints into the dipping frames used in the manufacture of matches, &c.
127 E. J. Smith—Lingoes used in looms for weaving
128 B. Lietar—Composition to be employed in welding iron upon iron, &c.
129 C. E. Brooman—Manufacture of lace
130 D. W. Hamper—Preparation of finings for clearing fermented liquors
131 J. G. Franklin—Tanning
132 C. B. Marsden—Covering from sun or weather
133 W. Weldon—Manufacture of chlorine, &c.
134 W. Weldon—Manufacturing chlorine
135 R. R. L. Rosoman—Use of water pipes in combination of turbine wheels for the production of motive power for propelling ships

DATED JANUARY 19th, 1867.

136 J. Robertson—Manufacture of umbrellas
137 J. Harding—A new fastener or lock
138 A. V. Newton—Steam generator
139 J. Bate—Making moulds for casting fenders, and fitting bottoms to fenders
140 J. Grant—Signals on railways
141 J. J. Harrison—Looms for weaving
142 A. B. Childs—Separating foreign seeds and other impurities from seeds
143 W. Bull—Glass blowing
144 T. W. Wilson—Manufacture of watch cases, and apparatus employed therein
145 A. Upward—Apparatus used for boring and tapping gas and water mains, and fitting service pipes thereto
146 E. Slaughter—Locomotive engines

DATED JANUARY 21st, 1867.

147 R. Harlow—Wash basins, and supplying hot and cold water to the same
148 C. L. Loversidge—Tanning of hides and skins and apparatus employed therein
149 G. M. Wells—Lasts for boots and shoes
150 W. E. Gedge—Double hooked fish hook
151 R. Knustmann—Bricks, tiles, &c.
152 J. Rowley—Hardening, bleaching, and sweeten ing crude paraffin
153 W. McAndrew—Ginning cotton
154 J. Edwards—Horse shoe cushion

DATED JANUARY 22nd, 1867.

155 E. Tomlinson—Manufacturing articles from wood and other materials
156 W. Harrison, J. Harrison, H. Harrison, and B. Crossdale—Looms for weaving
157 T. M. Gladstone—Ships' anchors
158 W. A. Martin—Consuming smoke, &c.
159 J. Chretien—Raising and lowering heavy bodies
160 F. C. Rein—Conveying sound from preachers to the audience
161 W. Clarke—Blast furnaces and method of working the same
162 W. Exall—Boiler apparatus of portable steam engines
163 J. Northrop, S. Tetley, and W. H. Tetley—Fringing shawls, &c.
164 J. Patison—Production of illuminating gas
165 H. Bridgewater—Construction of turntable
166 W. E. Newton—Injectors for steam boilers

DATED JANUARY 23rd, 1867.

167 J. M. Stanley—Ladies' belts
168 C. Coleman—Crinoline skirts
169 W. Dennis—Letter boxes, etc.
170 S. Cook and G. Cook—Weft forks used in looms for weaving
171 A. Chamberlain—Lamps for burning paraffin oil and other volatile oils
172 H. A. Bonneville—Treating skins
173 J. S. Dronsfield—Grinding cards to be employed in preparing cotton, etc.
174 T. Ross—Lenses for photographic cameras
175 W. E. Newton—Cotton bale ties
176 J. Pinney—Burglar-proof safes and fastening the doors thereof

DATED JANUARY 24th, 1866.

177 A. Apps—Electrical apparatus
178 F. Palmer—Vessels of war
179 L. Thornton and E. Thornton—Railway sleepers and chairs
180 T. Taylor—Implement for playing games of skill and chance
181 C. E. Bro man—Working electric telegraphs
182 J. H. Johnson—Firearms
183 D. S. Chater—Chimney tops
184 W. P. Phillips, G. Phillips, and D. Pearce—Ecclesiastical devices and decorations
185 W. E. Newton—Blocking hats
186 G. B. Woodroff—Sewing machinery
187 F. Hutchinson—Stopper for closing bottles, etc.
188 G. Haseltine—Tack driver and carpet stretcher

DATED JANUARY 25th, 1866.

189 G. Clark—Guns, etc., and their construction
190 J. L. Davies—Lamps for illumination
191 W. J. Hill—Breech-loading guns
192 J. Wolstenholme—Safety valves
193 T. Berney—Defensive armour and bullet proof porthole covers for the defence of ships, etc.
194 F. H. McLauchlan—Improvements in tables
195 W. Burley—Securing lamps for railway and other carriages
196 W. Gray—Rolling and shaping metals, etc.
197 J. C. Haddon—Anchors
198 W. Pain—Stringed musical instruments
199 G. Haseltine—Spinning and twisting machinery
200 J. Clark—Packing bales and boxes of goods
201 W. Hartin—Ruling pens
202 W. E. Newton—Hammers
203 H. Boys—Training hops

DATED JANUARY 26th, 1866.

204 F. Stephens—Vermin and other traps
205 S. Carey—Iron channels, etc.
206 B. Hunt—Boots and shoes, etc.
207 J. Nolder—Infants' feeding bottles, etc.
208 P. Jensen—Wheel gearing
209 M. H. Lisman and E. Chambers—Cores for the sockets of metal pipes
210 J. A. Jones and R. Hewson—Furnaces
211 J. J. Lundy—Treatment of the residual matters resulting from and obtained in the purification and distillation of mineral oils, etc.
212 J. H. Johnson—Electric telegraph conductors and cables
213 T. Berney—Construction and forms of projectiles
214 E. Lichtenstadt—Portable or other water closets
215 E. Bellard—Looms for the manufacture of silk and other velvets
216 J. Taylor—Drawing rollers
217 G. Haseltine—Volute springs
218 E. H. C. Monckton—Butter
219 G. Haseltine—Roving and spinning wool, etc.

DATED JANUARY 28th, 1866.

220 C. Wheatstone—Electric telegraphs, etc.
221 E. H. Waldenstrom and L. G. Bass—Manufacture of metallic bolts
222 J. W. P. Field—Breech loading firearms
223 J. Poole—Metallic hoops for casks, etc.
224 H. A. Bonneville—Dressing all kinds of thread
225 C. D. Abel—Appliances for horse shoes
226 J. E. Mellin and C. H. Ulbricht—Boxes to contain dress cards for public distribution
227 W. H. Stallard—Admitting and regulating atmospheric air to gas burners
228 G. Haseltine—Machine for pulling flax, etc.

DATED JANUARY 29th, 1866.

229 W. Snell—Fireproof safes
230 F. C. Cambrelin—Lighting railway carriages with gas, etc.
231 J. Greenshields—Combination of materials to be used for illuminating gas
232 J. Heworth—Tramways and carriages for streets and ordinary roads
233 A. Donnet—Water wells
234 T. Williams—Doubling cotton, etc.
235 J. Hopkinson—Ventilation of mines
236 W. Dickinson—Looms for weaving
237 P. Jack and A. Coulthurst—Power looms for weaving terry and cut pile fabrics
238 J. Ritchie—Watch keys and other keys
239 W. W. Pocock—Holding and presenting cards etc. for distribution
240 C. E. Brooman—Cartridge cases
241 C. E. Brooman—Soap
242 E. de Neve—Producing certain colours from aniline and coal tar
243 W. E. Newton—Supplying steam boilers with water, &c.
244 W. E. Newton—Casting articles in iron and steel
245 H. Craven and J. Speeding—Mode of operation for winding, etc.
246 W. L. Wise—Breech-loading firearms

DATED JANUARY 30th, 1866.

247 J. H. Brown and W. Bull—Hats, etc.
248 T. C. Entwistle—Transmitting motion
249 T. Prideaux—Heating of malt, etc.
250 E. V. L. Ebershurg—A new article of food for infants and invalids
251 P. Ellis—Breech-loaded and needle exploding firearms
252 H. R. Fanshawe—Lighting of mines, etc.
253 L. C. F. Clerc—Lamps for burning petroleum
254 B. Hunt—Writing paper
255 B. Hunt—Gas regulators
256 S. Macaithy—Fastenings to boots and shoes, etc.
257 C. E. Brooman—Cleansing raw wool, etc.
258 J. F. D. Donnelly—Lighting fires
259 W. Lee—Lime kilns
260 W. R. Lanafear—Manufacturing syclets

DATED JANUARY 31st, 1866.

261 C. W. Siemens—Developing powerful electrical currents and discharges
262 G. A. J. Schott and J. S. Rosenthal—Improved species of yarn, etc.
263 E. J. Padbury—Pipes for smoking
264 C. E. Brooman—Treating and preparing silk
265 E. H. Hughes—Gilding glass
266 H. Roberts—Ships' pumps
267 J. H. Johnson—Common road traction engines
268 J. Lockwood—Furnaces, etc.
269 E. T. Hughes—Cutting screws
270 A. Craig—Fire grates and furnaces
271 D. A. Halket—Forging nails and spikes
272 T. Summerson—Railway crossings
273 T. Bullivant—Window sashes, etc.

DATED FEBRUARY 1st, 1867.

274 T. Cooke and C. F. Cooke—Raising water, etc.
275 J. Murray—Chimney tops
276 W. Fiskeu and D. Fisken—Steam boilers, etc.
277 G. Russell—Steam cranes
278 I. Baggs—Motive power
279 O. Monnet-Laverpiliere—Agricultural fecundating agent
280 S. H. Foster—Brace fabric
281 E. Walton—Mattresses
282 F. Ashford—Fastening and better securing bullion boxes, etc.
283 H. Ermen—Doubling and twisting cotton, etc.
284 J. Bubrer and A. P. Price—Distillation of coal, etc.
285 W. E. Newton—Obtaining metals from their ores
286 N. T. Folsom—Atmospheric plates of artificial teeth
287 F. Baumau—Separating the fibres of woods into shreds, etc.

DATED FEBRUARY 2nd, 1867.

288 J. Darling—Reservoir penholders, etc.
289 J. Poole—Forming shafts, etc., with india-rubber surfaces
290 J. G. Robinson—Kilns and ovens
291 A. Bradshaw—Cock or tap
292 A. V. Newton—Steam generator
293 J. Smith and G. Wilson—Preparing and combing wool, etc.
294 W. Richardson—Horticultural buildings
295 H. B. Wright—Supplying steam boilers with water, etc.
296 E. S. Crease—Boring rock, etc.
297 J. Stubbs—Furnaces for the prevention of smoke
298 J. G. Tongue—Self-oiling spindles
299 R. D. Napier—Giving motion to machinery
300 D. Greig, R. Burton, and F. Parker—Tilling land
301 C. Vero—Manufacture of hats
302 C. P. S. Wardwell—Making machine knitting needles, etc.
303 B. Harlow—Boilers applicable to the generation of steam and other purposes

DATED FEBRUARY 4th, 1867.

304 W. J. Baker—Signalling between passengers guards, and drivers of railway trains
305 G. W. Betjemann—Envelope cases, etc.
306 M. Cockerell—Locks
307 J. F. Philippi—Pianofortes
308 Sir J. Benson—Armour plates for ships, etc.
309 S. Plant and W. Tatton—Fire lighters, etc.
310 W. Dewhirst, J. Dewhirst, and T. Dewhirst—Improvements in hoists
311 J. D. Bulloch—Self-fastening tie
312 Earl of Caithness—Floating beacons
313 C. Van Dusen—Printing names of subscribers on newspapers
314 J. J. Harrison—Looms for weaving
315 I. Liebich—Apparatus used when learning and practising to play on the pianoforte, etc.
316 G. Haseltine—Weavers harness

DATED FEBRUARY 5th, 1867.

317 P. M. Parsons—Permanent way of railways etc.
318 S. L. Lucenu—Horse shoes
319 J. Plews—Chambers of breech loading and other firearms and ordnance
320 T. Craven—Spinning frames
321 J. H. Johnson—Metallic cases for preserved food
322 J. Bulloubey—Vitrifying iron, etc.
323 A. V. Newton—Making foil of lead coated with tin
324 J. G. Tongue—Drying yarn

DATED FEBRUARY 6th, 1867.

325 J. Wright and T. Cobley—Treatment of ores of lead
326 J. Box—Opening and closing the passage through cylinders
327 W. E. Gedge—Improved paint
328 D. Barr and J. Bloxham—Window and shutter fastenings
329 J. Foxley—Bricks
330 G. A. Walter—Filtering beer, etc.
331 C. E. Brooman—Manufacturing and applying artificial pearls or beads
332 T. Rigby—Gun and pistol locks
333 H. Denn and G. A. Wheeler—Candlesticks and candle holders
334 S. Alley—Machine tools

LAUNCH.

IRON WORKS C° LIMITED

FIG. 2.

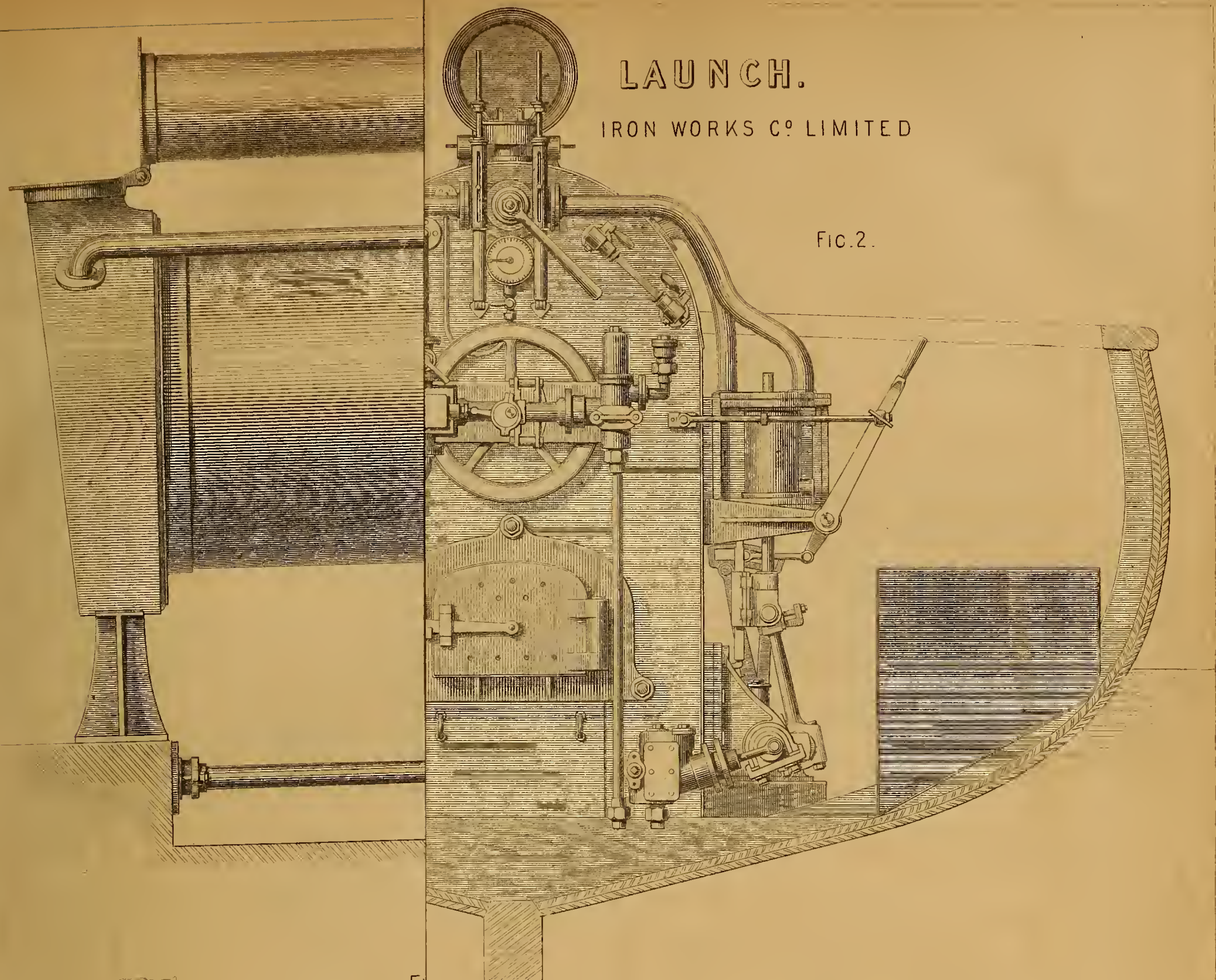


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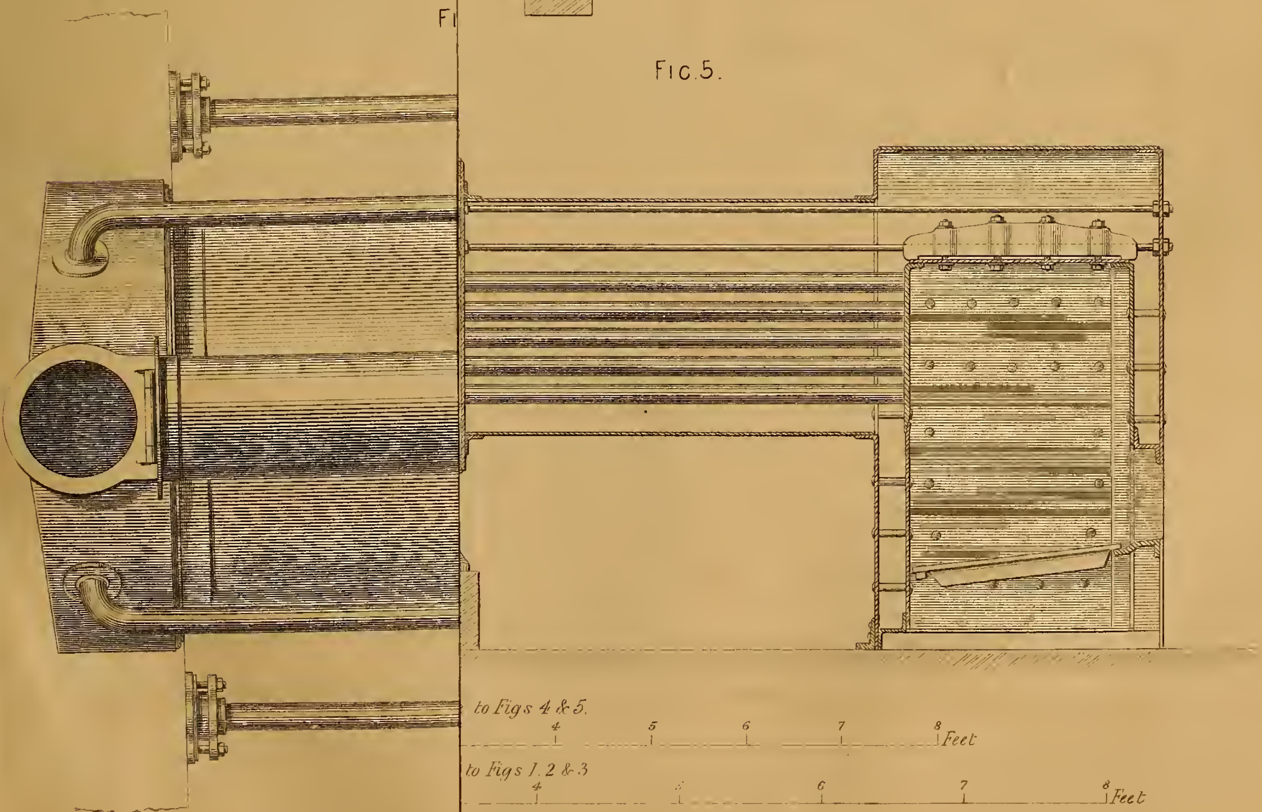
FIG. 5.



W. Smith C.E. direx

STEAM LAUNCH.

CONSTRUCTED BY THE THAMES IRON WORKS C° LIMITED

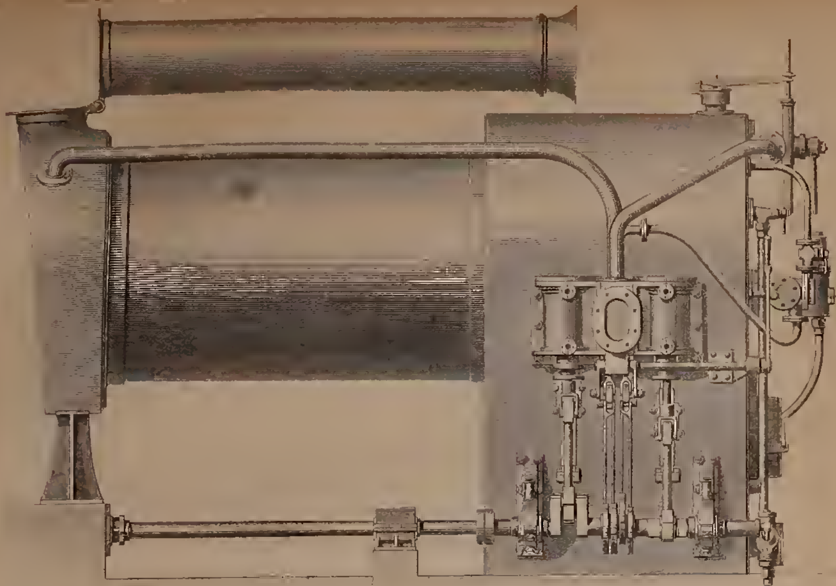


Fig 1

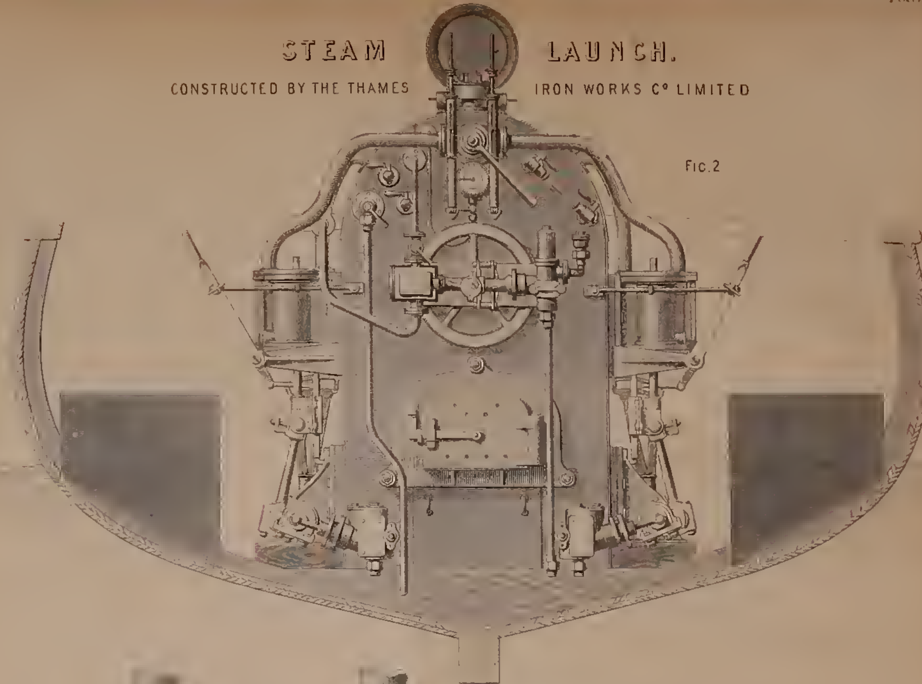


Fig. 2

Fig 3

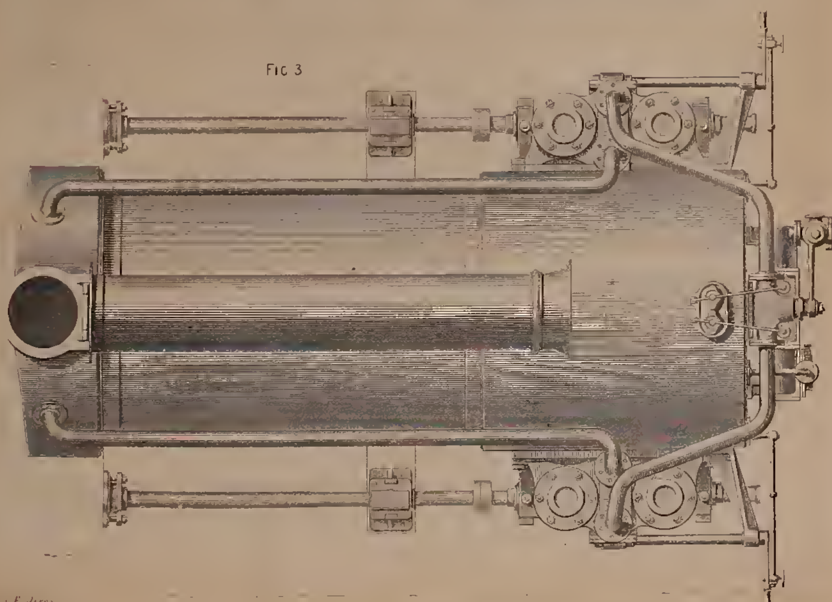


Fig 4

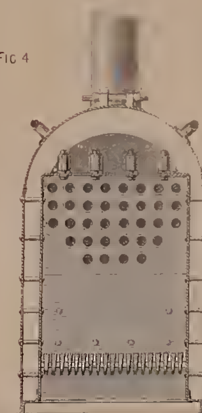
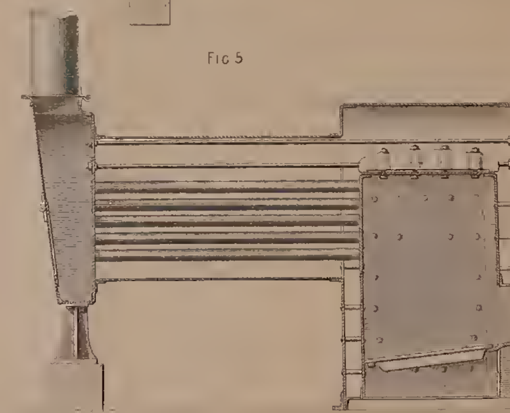
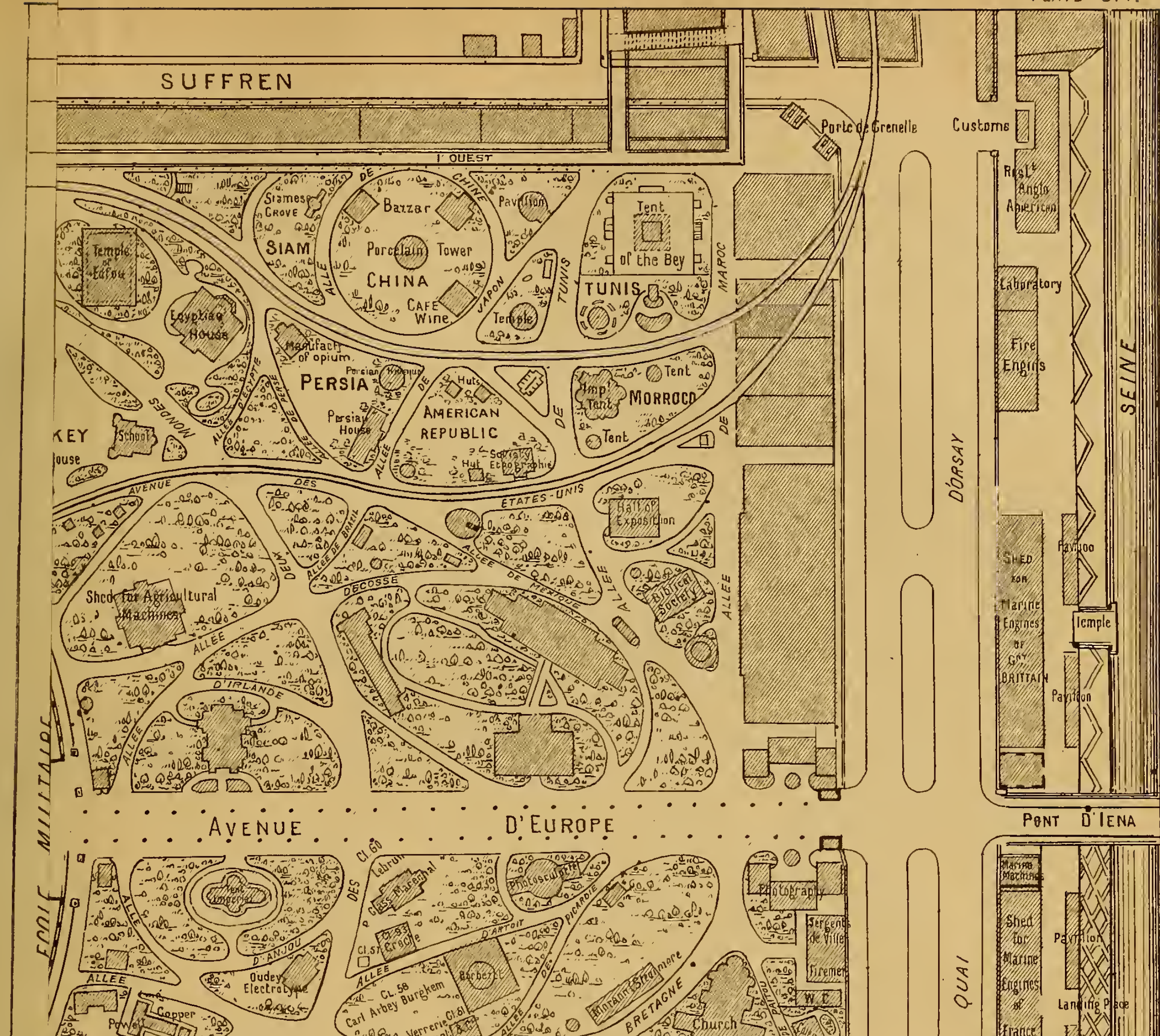


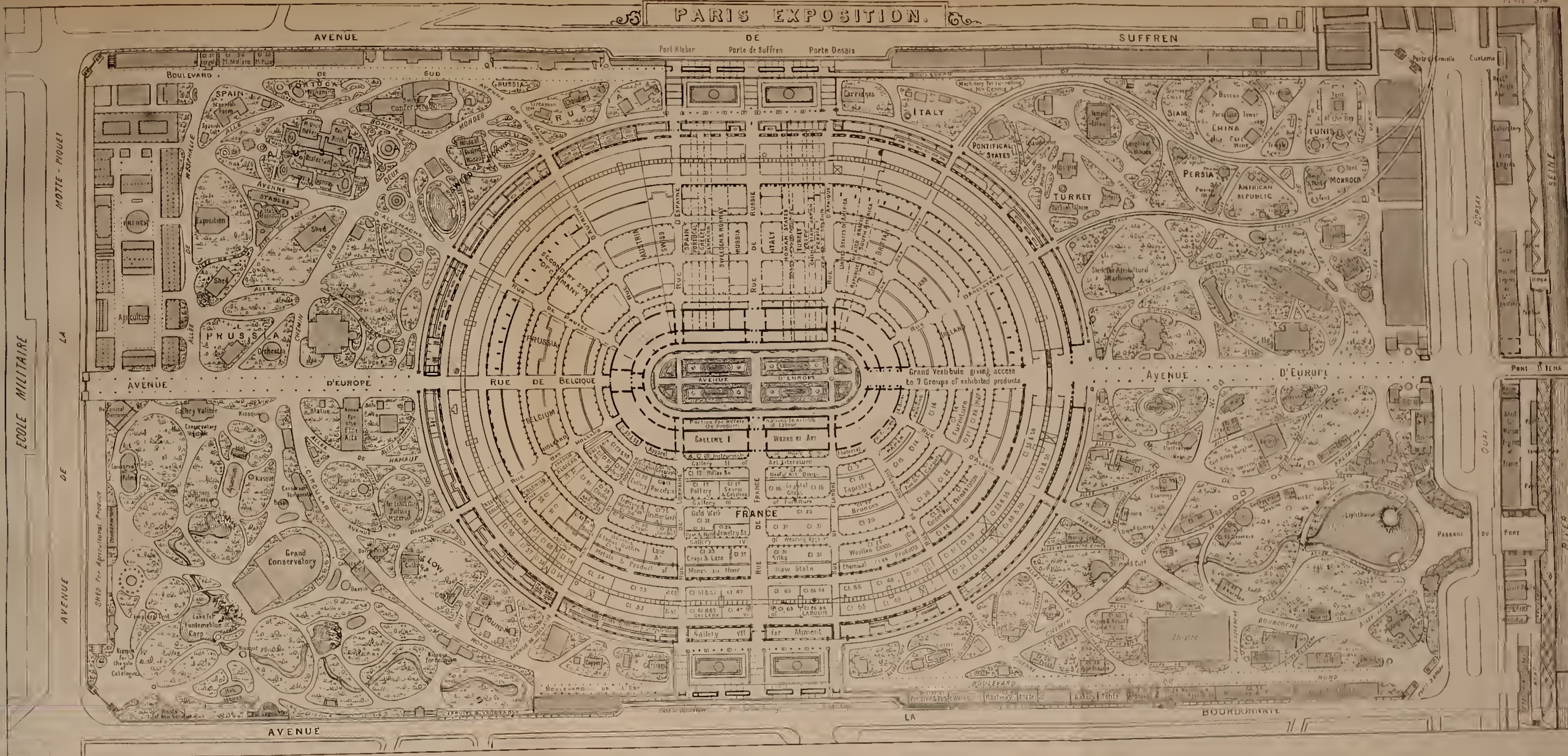
Fig 5



Scale to Figs 4 & 5

Scale to Figs 1 2 & 3


SUFFREN
Porte de Grenelle
Customs
Restt Anglo American
Siamese Grove
SIAM
Bazzar
Porcelain Tower
CHINA
Cafe Wine
Pavilion
Temple
Tent of the Bey
TUNIS
MAROC
Temple of Edfou
Egyptian House
Manufacty of opium
PERSIA
Persian House
Hut
AMERICAN REPUBLIC
Society Ethnographic
Imp! Tent
MORROCO
Tent
School
House
Laboratory
Fire Engine
SEINE
D'ORSAY
AVENUE DES ETATES-UNIS
Hall of Exposition
Biblical Society
Shed for Agricultural Machines
ALLEE D'IRLANDE
DECOSSE
Shed for Marine Engines of Gt. BRITTAIN
Pavilion
Temple
ECOLE MILITAIRE
AVENUE D'EUROPE
PONT D'IENA
Photography
Sergents de Ville
Firemen
W.C.
Photosculpture
ALLEE D'ANJOU
Oudey Electrotype
Copper
ALLEE DE CHAMPAGNE
Cl. 93
Social Economy
Church
BRETAGNE
ALLEE D'ORLEANAIS
Lighthouse
LIMOUSIN
Galobrun
Trost & Co
QUAI
Shed for Marine Engines of France
Pavilion
Landing Place
PASSAGE DU PORT
RIVER
Diamd Cutting
CIRCULAIRE
Cl. 35 Stumpf
Diamond Cuttg
ALLEE DE TOURAINE
Durand
Cl. 43 Bazenave
Cl. 49 Roulet
ALLEE DU FRANCOMOIS
Wash & Kerman
ALLEE DE SANTONGE
Pleasure Boats
ALLEE DE LYONRAIS
Cl. 50 Mignon & Renard Sherbet, Ices, &c.
Theatre
ALLEE D'AUVERGNE
BOURGOGNE
Ceramique Porcelaine
Bakery
Cl. 47 Girard
W.C.
Photography
LANGUEDOC
ALLEE DE SAVOIE
ALLEE DE DAUPHINE
Cl. 50 Type Presses
ALLEE DE BOURBONNAIS
DU NORD
Cl. 38 Tents
Cl. 30 Brass
Cl. 24 Warming & Lighting Apparatus
Cl. 54 Machines & Tools
Cl. 53 General Mechanics
PORTE D'ORSAY
BOURDONNAYE
FRENCH RESTAURANT
ROAD
W S.



W. SMITH C.E. direx

THE ARTIZAN.

No. 4.—Vol. I.—Fourth Series.—Vol. XXV. From the Commencement.

1st. APRIL, 1867.

ENGINES OF STEAM LAUNCH.

Designed and Constructed by The Thames Iron Works Co. (Limited), for R.S.S. *Victoria*, belonging to the Spanish Government.

If we remember rightly, it is now 20 years since the idea was put into practice of applying steam power to boats so small, or rather so light, that they could be easily raised or lowered from on board a man-of-war, by means of davits and tackle, and yet to be of sufficient buoyancy and capacity to perform all the functions required of a man-of-wars' launch. In about the year 1847 Captain Carpenter, R.N., had a pair of disc engines, each working a screw, fitted into a ships' pinnace belonging to the man-of-war he then commanded in the Mediterranean, this, though tolerably successful was not sufficiently so to cause the principle to be adopted. Probably, this result was chiefly owing to the defective design of the disc engines, and, partly, no doubt, to the size of the boat—a pinnace being too small to carry the required weight comfortably. Though, undoubtedly, this was an important step in the right direction, it does not seem to have been followed up for a considerable time, and it was not until about six years ago that the subject was again brought forward. In this case Mr. Samuel White, the son of the well-known shipbuilder of Cowes, constructed a small tender for a yacht, and about the same time the French Government made some trials with one which they had constructed, and which was found to be so useful that they immediately ordered them to be furnished to some of the principal line of battle ships in their navy. The Governments of various other countries shortly afterwards followed in their wake, and, lastly, as usual, our own Government commissioned Messrs. John Penn and Sons, and other engineers, to construct engines to be fitted to experimental boats. After repeated trials the advantages which were displayed over boats without the steam power were so great and so numerous that the question of its general adoption was reduced to one of time, and the overcoming of the prejudices of official persons. This, of course, with our Government, was no inconsiderable question, but at the present time many of the larger ships and iron clads are provided with them. The principal object in designing engines for boats of such small dimensions is the economy of space and weight, both as regards the engines and the fuel, and various designs have been made within the last three or four years by nearly all of the most celebrated engineers. Among the last (and, perhaps, one of the best, as we consider) are the engines of which we give an illustratative plate engraving in this number (Pl. 313), designed and manufactured by The Thames Iron Works Co. (Limited), under the superintendance of their manager of the marine department, Mr. Turner. We may mention *en passant* that this company have just completed their new marine engine shops, which seem to be models of convenience; and, what with self-acting travelling cranes up to 35 tons, and sheer legs up to 100 tons, and a remarkably fine shop of tools, they ought to be able to construct any kind of marine engines, and machines with very great facility;—especially as they have now entensive docks in immediate connection with their shops.

In the accompanying plate, No. 313, there are three principal views of the machinery of a steam launch for the Spanish Navy, and also two minor views of the boiler, being sections drawn to a smaller rule. Fig. 1 is a transverse section of the launch, showing a front end elevation of the boiler, with the two pairs of engines, the donkey-pumps, and the machinery and apparatus for driving the twin screw propellers; Fig. 2 a side view in elevation of Fig. 1; and Fig 3 a plan view of Figs. 1 and 2. In the two views, Figs. 4 and 5, drawn to a smaller scale, the construction of the boiler is shown.

Two distinct pairs of inverted direct-action engines are employed, in which each cylinder is 5½in. diameter, and 6in. stroke. They are bolted on to the sides of the fire-box portion of the locomotive-shaped boiler, shown in the accompanying plate.

Provision appears to have been made for adjusting all the working parts as they wear, and also ample surface is given to the piston-rod guide The feed-pumps are worked by a stud fixed into the end of the crank-shaft. The pump suction, delivery, and check valves are all contained in one light brass casting, and the feed is regulated by a cock (also cast in) between the delivery and check valves, and communicates with the suction pipe—thus permitting the whole, a portion, or none of the feed water to enter the boiler, as may be required, and thereby keeping the valves always wet and at work. It will be seen, too, that the position of the pump with reference to the water-line admits of a free inlet by gravity alone.

The donkey-engine and all the boiler mountings are in the front, and equally accessible.

The screw propellors are right and left handed, with three blades 4ft. pitch, and 2ft. 6in. diameter.

The boiler is of best Staffordshire and Yorkshire plates, wrought iron throughout; the barrel is 2ft. 6in. diameter, and 4ft. 5in. long, and the fire-box portion is 3ft. 6in. broad and 3ft. long. There are 34 tubes, each 2¼in. diameter, and 4ft. 9in. long, the heating surface of the tubes =103·36 square feet, and of the fire-box = 31·36 square feet, and the total heating surface is 134·72 square feet, and the fire bar surface is equal to 5·63 square feet. The chimney is 10in. diameter; the boiler steamed freely, and the engines worked well. We consider, however, that more attention should be paid to the perfect balancing of such quick running engines.

Subjoined are the particulars of a trial trip that took place on the 12th December:—

Mean speed	8.548 knots.
Revolutions	340 to 350
Indicated horse-power	55
Pressure in boiler	75 to 80

The following are the weights:—

	tons	cwt.	qrs.	lbs.
Engines and boiler, with wood lagging pipes, chimney, shackles for lifting feed engine, fire-bars, firing tools, spanners, coal cases to contain 15 cwts. coal, and floor plates	3	5	2	9
Propellors, shafts, stern tubes, with their brackets, thrust blocks and sea cocks	0	15	3	18
Water in boiler	0	14	2	7
Bearers, chocks, &c.	0	8	2	24
Total weight of engines and boiler with water	5	1	3	2
Weight of boat	3	18	3	7
Total weight of boat and engines ready for steam	9	0	2	9

In addition to these weights there were one ton of coal and other stores, and sixteen persons. The weight of machinery is 207lbs. per

indicated horse-power, and it is believed is the lightest yet attained by this class of engine. The workmanship throughout unexceptionable, and the engines worked to the satisfaction of all concerned.

The dimensions of the launch are:—length 41ft. over all, by 11ft. in breadth. The mean draft on trial was 5ft. 5in.

The subject is one which is deserving of attention, and it is to some extent receiving it at the hands of the English Admiralty people. If, however, these boats in addition to being fitted with steam machinery for propelling, were suitably constructed as lifeboats, they would be still more efficient and serviceable for the purposes for which they may be employed; a perfectly safe steam lifeboat launch is a thing to be obtained, and lifeboats that won't "turn turtle" are certainly more desirable for practical use in life saving than so-called lifeboats that do turn turtle even though they may be so-called "self-righting." In the case of applying steam machinery to such boats as ship's launches in the Royal Navy, the fact of the boat being a safe and reliable lifeboat will give greater confidence to the crew, and the knowledge that the boat is not designed for turning over and "self-righting," will go far to remove the unpleasant feeling that attaches to close proximity between a boat's crew and the steam power in such small boats.

We are glad to find that the Spanish Government, if not the foremost, is not the last to adopt an impartial step in the right direction, by having steam launches for their ships.

THE PARIS EXHIBITION.

(*Illustrated by Plate No.* 314.)

In the summer of 1865, the Emperor of the French issued a decree that a great exhibition of art, agriculture, and industry should be held in 1867, in the Champ de Mars. It was decided to erect a temporary building for the purpose, surrounded by a park, the latter being designed for the reception of living animals, plants, and other objects not suitable for exhibition within the building. It was also arranged that the Exhibition should open on the 1st of April, 1867, and close on the last day of October of the same year.

Towards the close of July, 1865, a committee was appointed to make the objects of the Exhibition thoroughly known throughout the empire, and to attend to other necessary preliminaries. In September of the same year the works were commenced by the construction of a grand avenue, 100ft. wide, traversing the entire space of the Champ de Mars, from the Quai to the Ecole Militaire in the rear. The railway was also commenced which now places the Exhibition in connection with all the great lines of France, by means of the railway running round Paris. From this date the works and the building itself progressed rapidly towards completion, and now all is ready for the opening ceremony upon the day appointed nearly two years ago.

The Exhibition building was designed upon purely utilitarian principles, being destitute of upper galleries with their accompanying staircases, and not being specially remarkable for beauty of architecture. The Emperor calls it his "gasometer," and some people compare it to a "dish." It has semicircular ends with a very short body, and is nearly oval in shape, with an open space in its centre, which has been formed into a garden. The whole is cut into four great divisions by two large avenues passing straight through the park, the building, and the central garden, where these avenues cross each other at a right angle. The building itself consists of a series of oval belts or galleries surrounding the central space, and divided by large and small avenues, which radiate from the inner garden like the spokes of a wheel. It is thus divided into wedge-shaped segments, one or more of which has been allotted to nations represented at the Exhibition, so that visitors who wish to see productions of one particular country will have to keep to the galleries in the divided portion, but those who wish to examine a particular class of goods, as represented by all nations, must keep to one gallery and follow it all round the building. The arrangements are thus very simple, and appear likely to prove eminently satisfactory to visitors. The building is 1,600ft. long by 1,200ft. wide.

The machine power used in the building is not supplied by the Imperial Commission, neither is it confined to one particular space, it having been arranged that the motive power shall be produced by private contract, preference in most cases being given to tenders from natives of that country whose machinery is sought to be driven. The buildings for the boilers or other sources of motive power are thus scattered round the outside of the main edifice. The park is divided among the several nations represented in the building, and is devoted to agricultural and horticultural matters, manufactures on a large scale, and all kinds of miscellaneous purposes. The river Seine flows past one end of the park, which has here had a special landing-place constructed for passengers from the steamboats, so that there is ready communication with the Exhibition by water, rail, and the numerous thoroughfares which open into those surrounding the Champ de Mars.

A serviceable, useful building, with surrounding grounds, having been thus designed, and since carried out, it remained to draw up a plan to govern the movements of intending exhibitors. The Imperial Commission had the control of all arrangements relating to France and its colonies, but the management of the space devoted to Great Britain and other nations was left in the hands of commissioners appointed by the respective foreign governments. The Imperial Commissioners, therefore, have had no communication with any foreign exhibitors, who have all been referred to their own representative body, which also has had to arrange for the carriage, reception, and return of all goods exhibited by their countrymen. These goods have been sent to the Exhibition subject to the following conditions:—No work of art or object exhibited in the building or park may be drawn, copied, or reproduced in any manner whatever, without the authority of the exhibitor; but the French Government reserves to itself the right of taking general views of the Exhibition. No object exhibited may be removed before the close of the Exhibition, without the consent of the Commissioners. No exhibitors have to pay any rent for the space allotted to them, but all costs for fittings and decorations in the Exhibition building have to be borne by them. The Imperial Commission will furnish, without charge, water, gas, steam, and motive-power for the machines. This motive-power is transmitted by a horizontal main shaft, but the exhibitors have to furnish driving pulleys, connecting pulleys, and all intermediate shafting which may be necessary. The French Commissioners will take every precaution to preserve from damage the articles exhibited, but will not hold themselves responsible for any injury the goods may receive, whatever may be the cause; so that exhibitors must take upon themselves the cost of insurance, if they desire so to do. A non-transferable ticket of admission is given to each exhibitor, who is required to enter by a particular door, and to sign his name in a book, when asked, for the purposes of recognition. Conferences may be held and demonstrations given in various parts of the Exhibition. Courses of lectures and readings may, in addition, be delivered in a room built for that purpose. These various means of imparting information can only be used by those who have personally obtained the authority of the Imperial Commission. Lastly, immediately after the close of the Exhibition, the exhibitors must begin to pack and remove their goods and fittings. This operation must be completed before the 30th November, 1867. After that date the goods, cases, and fittings which may not have been taken away by the exhibitors, or their agents, will be removed and deposited in a public warehouse, at the cost and risk of the exhibitor. The objects which, by the 30th June, 1858, may not have been removed from that warehouse will be publicly sold, and the net proceeds of the sale will be applied to some work of charity.

Such is the general plan of the building, and the arrangements respecting exhibitors. To descend more into detail, it may be stated that on entering the Exhibition the visitors first cross a covered colonnade 16ft. 3in. wide, surrounding the whole building. The first gallery then entered is 32ft. 10in. wide, by 24ft. 6in. high. The next is the highest gallery of all, and forms, when viewed from the outside, a most prominent feature of the building. It is 111ft. wide, and nearly 82ft. high, the roof being semi-circular in shape. Still passing inwards, the next two galleries are each 76ft. wide, by 24ft. 6in. high, and three smaller ones have yet to be passed before the central garden is reached. This garden is surrounded by a covered colonnade, so that in wet weather there is plenty of shelter in any part of the grounds.

The inner galleries and the inner colonnade are built of solid masonry, with roofs of iron and glass. The outer and larger galleries are made throughout of wrought iron, the roof also being made of this material; the light is admitted through high side windows, opening above the roofs of other galleries. The intermediate galleries have light trussed wrought iron roofs, covered with iron and glass; the principals are supported on hollow cast iron columns, joined by wrought iron web girders, the columns at opposite sides of the walk being also united by wrought iron trough girders. Sometimes very large columns were necessary, in which case they have been made in two parts, the lower one being bored out at the top to admit a nearly corresponding projection from the lower part of the upper column. Four screws bear against the lower end of the projection from the upper column, whilst the flange bolts enter large holes. The upper section of the column has been thus adjusted in position by means of these screws, and, once properly fixed, the heads of the bolts were cut off, leaving the lower column flush.

The grand nave or largest gallery contains eighty-six pairs of great pillars, each 84ft. high, 3ft. by 2½ft. at the base; the eighty-six great

girders necessary subtend a chord of 109ft., and have a section of about $2\frac{1}{2}$ft. square. The plate used varies from $\frac{1}{4}$in. to $\frac{3}{8}$in. in thickness. The great tension rods above the girders are put together in three lengths, and are 116ft. long from end to end. The section of the pillars is that of the box girder, built up of side plates and angle irons, the size of the outside of the hollow parallelogram thus formed being 3ft. by 2ft. 7in. They each rest upon a block of masonry 5ft. square. Angle irons $4\frac{3}{4}$in. by $3\frac{1}{8}$in. by $\frac{1}{2}$in. pass on each side of the column, and extend beyond the edge of the block, so that bolts $1\frac{1}{8}$in. in diameter can pass outside the stone, which has corresponding angle irons let into it, at a depth of 3ft. 3in. from the top The fastening-down bolts consequently pass through both these angle irons. In the columns themselves the angle irons are $2\frac{3}{4}$in. by $2\frac{3}{4}$in. by $\frac{3}{8}$in., and the plates of the shorter sides are $\frac{1}{4}$in. thick. The longitudinal girders couple the columns together as the felloes of a wheel couple the spokes. The colonnade outside the great nave will be nearly a mile long, and 22ft. wide, forming a splendid sheltered promenade all round the building, with diversified views of the park and its contents. Round the exterior of the park a high bank has been raised, to shelter the visitors from rough winds as much as possible, and to render the grounds more private than would be the case were they exposed to a full view of the outside public. Close inside the principal entrance buildings have been erected for the purposes of photography and photo-sculpture; refreshment rooms are built in most parts of the grounds, and all round the back of the outer colonnade are cafés and restaurants.

The contracts for the construction of the exhibition building were taken by eminent French firms, who have had to yield to somewhat stringent conditions. According to the conditions laid down by the Imperial Commission, they had to furnish testimonials and security, and those contractors whose tenders were not accepted were not indemnified for any expenses. The successful competitors were not allowed to make a sub-contract without written authority, and were ordered to conform strictly to all drawings, tracings, or orders given by the engineer or architect. During the progress of the work, the contractor was bound to be present, or in case of his absence to nominate a representative with full acting powers. In cases of insubordination, incapacity, or dishonesty, the engineer or architect had the right to demand the dismissal of agents or workmen of the contractors. All materials used in the building had first to be examined by an inspector, and in those cases where they afterwards turned out bad or unsuitable, the contractors had to replace them at their own expense. No indemnity was allowed to the contractors for changes in the prices of materials during the progress of the works, and, say the Commissioners, "Should the contractor refuse to conform to the orders of service, the Commission shall be empowered to place him in confinement for a fixed time. If, after the expiration of this delay, the contractor still persist in his refusal to go on with his work, a *proces verbal* of the circumstances will be placed before the Commission, in order that it may determine the measures to be adopted. Every order endorsed 'urgent' must be executed within twenty-four hours. In default, the Imperial Commission may strike out of the contract such work declared 'urgent,' and cause it to be executed as seems best without further affecting the works which have to be done by the contractor." At the end of every month, each contractor had to draw up a statement of the amount of work done, which was then certified, and payments made to the extent of nine-tenths of the full value according to the heads of the contract, the other tenth being retained for the final settlement.

As regards ornamentation the building is throughout, as a rule, painted of a bright chocolate colour, with a little gilding and brilliant colouring to relieve the monotony of the above ground. In the park the buildings are mostly of coloured brick, and, as a rule, highly ornamental. The houses for motive power are so built, and are situated at equal distances, in a ring, about 80ft. from the main building. Twelve firms have contracted to supply the necessary motive power, each firm having its furnaces, boilers, and other machinery in a separate building. The names of these exhibitors are Messrs. Thomas and Powell, of Rouen; Le Gavrain and Son, of Moulins-Lille; Lecouteux, of Paris; Chevalier and Duvergier, of Lyons; Quillacq, of Auzin; Baron de Bussiere and M. Mesmer, of Graffenstaden; Boyer, of Lille; Scott, of Rouen; and Madame de Coster, of Paris. The British Commission has reported to English exhibitors of machinery, that the pressure of steam in the boilers will be 60lbs. per square inch, and somewhat less in the Exhibition building, according to position. Water can be had under a pressure of a few feet head, near to every exhibitor's stall, but it can be also be had under a pressure of 98ft. head, by laying a pipe from the main which adjoins one side of the British space. Steam is exhausted into pipes within moderate reach of each exhibitor, and waste water is carried off with equal facility. The original ground under the machinery gallery is not reached for some 7ft. or 8ft. from the floor level; the made ground is, however, well consolidated. The largest pulley that can be used is 3ft. 6in. in diameter, and the diameter of the driving shaft varies.

The buildings in the park exhibit an endless variety of size and shape—the Emperor's pavilion, the Queen of England's pavilion, mosques, and Egyptian temples, model houses and cottages, a club-house, a theatre, a bake-house, a candle manufactory, a great glass establishment, and a number of other structures. At the city end of the park is a large range of glazed sheds for the exhibition of carriages. and the accommodation of the carriages and horses of visitors, who will have to pay fixed fees for the privilege. But the most interesting piece of work in the grounds to most of the visitors will be a gigantic aquarium, in which it is hoped to confine a large shark or two, and other remarkable sea-monsters. To hold the aquarium a large cave has been built, lighted at both ends, and in this the aquarium will be built up of plate glass supported by slender iron pillars, the sides being about 20ft. high. A cascade and reservoir has also been built to aerate and renew the sea water in the aquarium. The visitors will be able to view the motions of the fish from above, from below, and on all sides. The cave itself is very roughly built of masonry, with numerous interior pillars, which will all be covered with artificial staglamite to resemble stalactite. A fresh water aquarium has also been built in another part of the grounds.

The miscellaneous mass of buildings in the grounds are necessarily surrounded with flowers, trees, and shrubs, intermixed with a sprinkling of gas-lamps and lamp-posts, the whole having a peculiar effect, certainly not wanting in variety. A canal with an artificial lake and lighthouse have been constructed. Outside the park two very large buildings have been erected as restaurants, both of them belonging to a Parisian speculator, but one of them placed under the management of Englishmen, for the benefit of English and American visitors. The bad weather of the past two months has prevented the completion of many of the buildings in the grounds, but the Exhibition itself will be ready for the opening ceremony on the 1st of April, as originally contemplated.

THE MACHINERY EXHIBITED IN THE PARIS UNIVERSAL EXHIBITION.

The great machinery gallery is now (25th March) being rapidly filled, and the preparations for the coming opening are well advanced. The four steam cranes in the English department are doing great service in the unloading of heavy goods.

The ornamental boiler house is nearly completed, and the boilers are ready for work. They consist of three Galloway boilers of 46 nominal horse power each, a 30-horse water tube boiler by Howard, of Bedford; and one of equal power on a somewhat similar principle by Messrs. Hayward and Tyler, of London.

Messrs. Galloway and Sons are also fixing a pair of horizontal engines of 100 h.p. in the building for the purpose chiefly of driving the cotton machinery of Messrs. Platt Brothers, of Oldham.

Messrs. Hick, Hargreaves and Co., of Bolton, also have a horizontal engine ready for work.

Two Allen engines by the Whitworth Company are now in working order; the first is of 25 nominal h.p., and the other is intended to make 1,000 revolutions per minute, the cylinder is 6in. diameter, with 12in. stroke.

There is a good show of heavy machine tools in place by the Whitworth Company, De Bergue and Co, Sharp, Stewart and Co., Shepherd, Hill and Co., &c. Messrs. Worsoam's wood-working machinery, a steam hammer by Messss. Thwaites and Carbutt are also being fixed.

Messrs. Shand and Masons's steam fire engines *La Seine* and *Le Rhône* are at present the only ones arrived.

The English locomotives are represented by an express engine by Messrs. Stephenson, of Newcastle, with 6ft. 6in. driving wheels and inside cylinders 16in. diameter, with 22in. stroke; an engine by Messrs. Kitson and Co., of Leeds, with inside cylinders. The Lilleshall Company, of Shiffnal, send a passenger engine with 7ft. driving wheels.

A small four-wheeled coupled colliery or contractor's engine by Hughes and Co., of the Falcon Railway Plant Works, Loughborough. The cylinders are outside 12in. diameter, with 20in. stroke.

Messrs. Ruston and Proctor, of Lincoln, also exhibit a small locomotive weighing about $9\frac{1}{2}$ tons. The cylinders are outside, 9in. in diameter, by 20in. stroke; the four wheels are coupled and 2ft. 9in. in diameter.

The rails under Stephenson's engine are laid with Dering's patent spring clip fish joints, spring keys and spring trenails.

The British ordnance is now being arranged in a building for the purpose in the park. The principal object of interest, no doubt, will be the 12in. muzzle-loading rifled gun, weighing 23 tons, mounted in the centre of the building. A 9in. and a 7in. muzzle-loading rifled gun, weighing respectively 12 tons and $6\frac{1}{2}$ tons, are mounted on each side. Several breech-loading guns, of large calibre, are also on each side. The building for the exhibition of private ordnance, in which Armstrong, Whitworth, and John Brown occupy the principal space, is quite finished.

The English marine engines are now being fixed in a well lighted and commodious building fronting the Seine. The heavy portion of Messrs.

Penn's 350 horse-power engines are in place. The Admiralty, amongst other things, exhibit a steam launch, 42ft. in length, with twin-screw engines. The propellers are four-bladed, 2ft. 6in. diameter.

The French portion of the great machinery gallery is being well filled. Most of the fixed engines for driving the machinery, by Farcot of Paris, Boyer of Lille, Duvergier of Lyons, Lecouteux of Paris, and Quillacq of Auzin, are now ready for work.

Mazaline, of Havre, is exhibiting a good many machine tools of excellent workmanship; Bouhey, of Paris, some heavy punching, shearing, and drilling machines. M. Perrin, who first showed the hand-saw at Paris in 1855, is exhibiting a large hand-saw for cutting up rough logs 4ft. in diameter.

The French department contains examples of engines, the designs of which will not fail to be criticised by English engineers.

The well-known firm of Parent, Schaken, Cail and Co., of Fives-Lille, exhibit a heavy gradient engine for the Chemin de Fer du Nord, weighing, when in working order, upwards of 44 tons. The cylinders are outside, and the eight wheels, 4ft. 4in. in diameter, are coupled.

A four-cylinder heavy gradient goods engine, "*Le Titan*," constructed by M. Gouin for the same company, is exhibited by M. Petiet, the engineer. The six pairs of wheels are coupled in groups of three. A tubular steam chamber is placed above the boiler and the chimney, on account of the great height above the rails, is placed horizontal, so as to be of sufficient length.

The Paris and Orleans Railway exhibit a ten-wheeled coupled goods engine, "*Le Cantal*," with outside cylinders $19\frac{4}{10}$in. in diameter, with 25in. stroke. The wheels are 4ft. in diameter. This engine, when in working order, weighs 55 tons. They also exhibit a six-wheeled passenger engine, the driving and leading wheels are coupled, and are 6ft. 6in. in diameter.

A passenger engine of the design in general use upon the Chemin de Fer de Lyons is exhibited by M. Marié, the locomotive superintendent. The coupled driving-wheels are 6ft. in diameter; the cylinders are inside.

A six-wheeled coupled engine, with steam tender, on Sturrock's system, is exhibited by the Eastern Railway. The cylinders are inside, 18in. in diameter, with $25\frac{1}{2}$in. stroke. The tender is provided with cylinders of of the same size, and with three pairs of coupled wheels.

A four-wheeled locomotive is exhibited by the Graffenstaden Works, on the Rhine; the cylinders are outside.

An engine for a 3ft. 4in. gauge, with three pairs of coupled wheels, is exhibited by Messrs. Boignes and Ramburg.

The 960 horse-power engines of the "*Friedland*" are being put together in a large building by the Pont d'Iena. They were constructed for the French Navy at Indret. The three cylinders are $82\frac{1}{2}$in. in diameter, with 5ft. stroke.

Four of the eight boilers are being fixed. The propellor is four bladed, 19ft. 6in. in diameter.

Messrs. Schneider and Co., of Creusot, are exhibiting in their own building in the park, 130ft. in length by 50ft. in breadth, three locomotives and two marine engines.

The Americans are exhibiting in the building a good deal of cotton machinery.

An American coal-burning engine has also crossed the Atlantic, and is now being fitted up on a line of rails laid for that purpose by Mr. Dering with his patent rail fastenings. This engine, the *America*, was constructed at Grant's Locomotive Works, New Jersey, and is of most excellent workmanship and finish. The framing is of square iron, instead of being composed of four longitudinal plates, as is the practice in Europe. The cylinders are outside, 16in. in diameter, with 22in. its other side. The driving wheels, 5ft. 6in. in diameter. are coupled to the trailing wheels, and the front of the engine is supported on two four-wheeled trucks. The housing for the driver of polished wood, with windows in front and sides, is very good and complete.

A ten-wheeled articulated tank engine, the *Steverdorf*, designed by M. Haswell for the Austrian state railway, is now receiving its last coat of paint.

M. Hartmann, of Chemnitz, exhibits a six-wheeled engine, the *Schwan*, with outside cylinder. The driving wheels are 5ft. 10in. in diameter, and are coupled to the trailing wheels.

M. Hartmann also exhibits a quantity of machine tools of superior workmanship.

M. Sigl sends an outside-cylinder engine, the "*Biala*," with six wheels.

The six-wheeled engine and tender, the "*König Wilhelm*," is exhibited by M. Borsig. The driving and trailing wheels are coupled.

A four-wheeled coupled engine, by Krauss, of Munich, is also in place.

A heavy gradient engine, adapted for sharp curves, is exhibited by the Société St. Leonard, of Liege. The cylinders are outside and inclined, with three pairs of coupled wheels, 4ft. 8in. in diameter, behind, whilst the front part of the engine is mounted on a four-wheeled truck.

The Société John Cockerill, of Seraing, near Liege, are fixing a large blowing engine with 9ft. cylinder.

Messrs. Escher, Wyss, and Co., of Zurich, exhibit a pair of compound cylinder paddle engines for lake navigation; they are of 120 nominal horse-power. Their machinery is extensively employed in the navigation of the Danube, where it has a high reputation.

WHO INVENTED THE SCREW PROPELLER?

Swan's Rotative Sculling Wheel.

Joseph Ressel's claim to the priority of the invention of the screw propeller, of which we gave an explicit account in The Artizan for February, 1867, has brought to light various claims that had lain dormant for many years. The date of none of these inventions, however, seems to be prior to 1812, the year in which the advocates of the Ressel claim allege their client's scheme to have been first propounded. Leaving our readers to judge the comparative merits of the various contrivances, each of which professes to be the original screw propeller, we purpose to reproduce from time to time descriptions of such of these combinations as may reasonably command the attention of the scientific public; and we hope we shall thus contribute to the final settlement of the important question, "Who invented the screw propeller?" We commence with Swan's "rotative sculling wheel," the account of which we here reproduce in full, such as it was given by Dr. Birkbeck, in the *Mechanics' Register*, vol. for 1825, p. 98 and following:—

Letter from Dr. Birkbeck to the Editor of the "Mechanics Register," Jan. 22, 1825.

50, Broad-streeet.

Sir,—Amid the eagerness with which the public are rushing forward to form plans for establishing communications by means of railroads, the old conveyance by canals is almost forgotten, and, indeed, from the prospect of gain and celebrity displayed by the projectors of these roads, it may be expected that the aid of water will soon be discarded. The proprietors of some canals, although much disposed to be supine, have, I believe, begun to take the alarm, and probably all will become alive to their danger when bills are presented to the House of Commons for forming railroads, acting, as is too often the case, for the defence of their own property by opposing the plans of the incipient speculators. Judging from the liberal spirit lately displayed by Parliament, I am inclined to suspect that they will not allow private interest to arrest the march of improvement, but they will permit railroads to be attempted in all directions, even if obviously in the way of older establishments, leaving it to the efforts of the competitors to prove with which plan the superiority rests.

Presuming, then, that the canal proprietors will be compelled to sustain a competition, I wish to suggest to them a mode by which their movements, more fit for the torpor of past ages than the enterprise of the present period, may be accelerated. And as they do possess some advantages over their opponents, the suggestion which I am about to make may, if properly applied, preserve for them a superiority which otherwise they could not maintain.

It is not necessary here to remark that the use of steam constitutes the distinguishing feature of modern improvements. This power has in some degree superseded the use of wind in navigation, and of wind and water as the prime movers of machinery. It is now nearly ready to supersede the use of horses upon our roads; at least, hydrogen, one of the constituents of steam, is about to do so; and if it be not also found in the place of horses as the impeller of barges upon our canals, inland navigation must soon be discarded. To drag several barges in succession by a steamboat is a plan which I have no doubt has occurred to many when thinking upon this subject, but the inconvenience of the paddle-wheels generally used, and especially the injury done by them and the agitated water to the banks, which are necessarily very near to the barge, have appeared insuperable difficulties. In general steam navigation I have always considered the paddle-wheel the most imperfect and objectionable part of the arrangement; the manner in which it strikes the water is attended with loss of power; it is dangerous if approached by small boats on account of the swell which it occasions; and in a stormy sea or river it appears to be ill adapted to continuing the motion, or resisting the waves which dash against the vessel. Thus impressed with the necessity of improving the method of propelling vessels by steam, I was much gratified by receiving an invitation to be present at the exhibition of a new and improved mode, by way of an experiment, on a sheet of water in the grounds of Charles Gordon, Esq., of Dulwich-hill. This experiment, conducted by

the inventor, who is in the employment of Messrs. Gordon's, I had lately the pleasure of witnessing, and the result was so satisfactory that I am anxious to direct the attention of engineers in particular to it. The velocity and steadiness of the motion so far exceeded that of the same model, when impelled by paddle-wheels, moved by the same spring which worked the new contrivance, that I could not doubt of its superiority; and the stillness of the surrounding water was such as to give to the vessel the appearance of being moved by some magical power. In a comparative experiment made by the ingenious and modest inventor, and frequently repeated, it appeared that the velocities of the model, impelled according to the old mode and the new spring, by the same, was as seventeen to twenty.

Before describing the sketch, which I have transmitted with this letter, I will insert the account of his plan, which I received from the inventor.

Letter of Mr. Swan to Dr. Birkbeck on Swan's rotating sculling wheels. From the "London Mechanic's Register," Jan. 22, 1825.

Honoured Sir,—According to your request I send you my remarks on the rotative sculling wheels for propelling vessels. First, I would notice their compactness in not occupying one-fourth part of the space that common wheels do. As seen in the plan, they may lay in harbour with other vessels without any danger of being injured at all, which is at present a great inconveniency. Secondly, the superior advantage in a rough sea, in which they act the same as in a calm pool, being entirely beneath in the solid dense water; and, besides, their weight, from their situation, as will plainly appear, will be as ballast in the hold, an object at sea, worthy of consideration. Thirdly, from their situation beneath the surface they are not liable to be impeded by floats of ice or by storms; therefore, I think they might be suitable to packets for despatch, and might be used all the winter. Fourthly, they make no swell or commotion, either disagreeable or dangerous in the water, as the common wheels do when lighting in a fermentation of air and water; but go as smoothly as a vessel under sail, their action being in the solid water as a lever upon a rock for a fulcrum. I shall decline saying any more at present upon the principle, and leave it, Sir, to your very superior judgment to comment upon. The apparatus has been shown several times to some gentlemen of the first respectability and genius, both mechanical and nautical, and has constantly met with the highest approbation.—I remain, &c., John Swan.

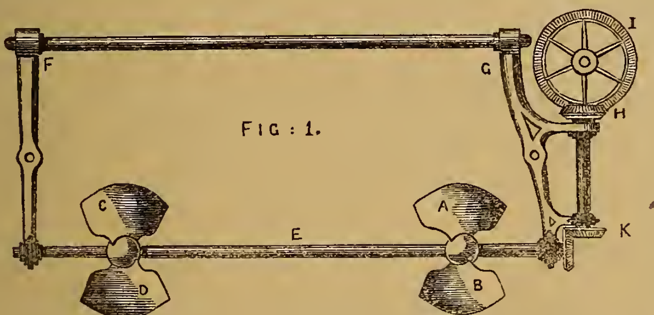


FIG : 1.

35, Deptford-green, Sept. 28, 1824.

On the axis E fig. 1, supported by the framework F, G, are placed the vanes A, B, and C, D, having a surface equal to that of the floats of the paddle-wheels, which are immersed whilst acting: these are situated with respect to each other, that whilst working they act as a screw within the water, and thus draw the vessel forward. The angle, which these planes make with their axis, is about 30 degrees. At H is seen the end of the crank, on which the wheel I is fixed to convey the motion of the engine through the tram K, H, I. This machinery, however, is merely a suggestion; and, probably, a better and more simple mode might be devised for producing the requisite motion. The convenient manner in which this plan adapts itself to the vessel is observable in the end view fig. 2, where it may be seen to be entirely beneath that part of the deck which extends from A to B. The dotted lines represent the axes within the vessel, on which the wheels I I fig. 1, belonging to each side, are fixed; and F in the same figure shows the crank on one side. C and H represent strong bolts by which the apparatus is attached to the vessel, affording a very ready method of disengaging them, whenever circumstances may require such separation.

FIG : 2.

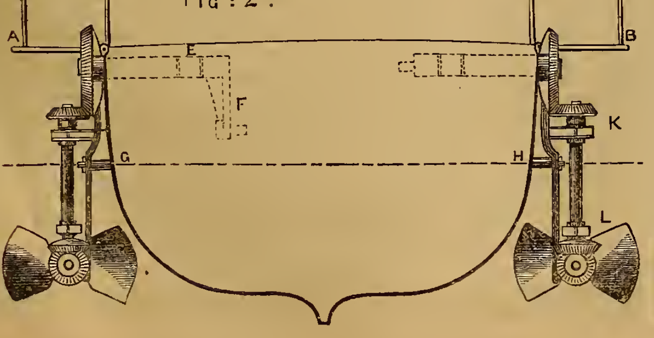
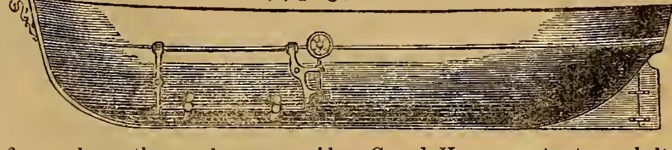


FIG : 3.



If by this description of what seems to be an excellent contrivance, I should be so fortunate as to obtain for the inventor the notice of any competent practical man, so that it might be applied in actual steam navigation, or if it tends, when introduced, to relieve the Canal proprietors from the difficulty into which they are likely to fall, it would be found to justify the favourable opinion of it now entertained by

Yours truly
George Birkbeck.

FLOATING STEAM FIRE-ENGINES FOR CALCUTTA.

On Wednesday, the 20th of March, and the following day, some interesting experiments took place above Blackfriar's-bridge, in order to test the capabilities of a floating steam fire-engine constructed to the order of the Indian Government.

The boat, which is made of iron, was built by Messrs. Richardson, Duck, and Co., on the Tyne, and is put together in segments, so that it may be taken to pieces and shipped to Calcutta. The boat-propelling power and general arrangement of the fire-engine pumps are to the design of the Government engineers at Calcutta, and the entire machinery was manufactured and fitted by Messrs. Shand, Mason, and Co., London.

The following are some of the principal dimensions, viz.:—Length of boat, 130ft.; breadth of beam, 16ft.; depth of hold, 7ft. 5in.

The engines, which are non-condensing, are placed horizontally across the boat, working the screw shaft direct at about 200 revolutions per minute, the screw propeller being 4ft. 6in. diameter. There are two cylinders, each 12in. diameter and 15in. stroke, with a pressure of steam in the boilers of from 80lbs. to 100lbs. on the square inch. The crank shaft of the engines is connected at the after end to the screw shaft by means of a sliding clutch, and at the fore end a similar clutch connects it with a shaft geared to the crank shaft which works the pumps by means of a mortice wheel and pinion.

The boilers are four in number, with cylindrical shells and fire boxes and horizontal brass tubes. Three of the boilers are quite sufficient to work the engines to their full power.

The fire-engines consist of three pairs of bucket and plunger pumps placed diagonally, and worked by a three throw crank; the barrels of the pumps in each pair being placed at right angles to each other, and worked from the same crank. The pump buckets are 10in. (bare) diameter, and have a 12in. stroke. The water is drawn from a well constructed on each side of the boat, the skin of which is perforated. Each pump is fitted with a stop valve in the suction pipe to allow the valve covers to be removed, or any pair of pumps to be disconnected, so that one, two, or three pair may be used at one time; there are also arrangements for attaching flexible suction pipes by means of which the pumps might be used for drawing water from the holds of vessels.

The floating engine shortly after twelve o'clock on March 20th started up the river, having on board several gentlemen who are interested in fire-engine matters. The speed was considered very good, being from 12 to 13 miles per hour; the above-bridge boats being passed very easily. A high rate of speed in this case is of great importance, as the swift current of the river Hoogly has to be encountered.

The hose outlets are six in number, each provided with one of Captain Shaw's stop-valves; to these six lines of hose were attached with a jet of $1\frac{1}{2}$in. diameter at the end of each. With the engines working at full power the water pressure reached over 100lbs. on the square inch, indicating that a vertical height of upwards of 150ft. was reached by the water.

Several diagrams were taken from the engines by a Richards's indicator, the highest of which gave 290 horse-power.

The whole of the machinery worked very smoothly and well, and the workmanship appeared remarkably good.

It would perhaps have been better if the counterbalance had been placed directly behind the cranks of the engine-shaft, as there was rather too much vibration felt on deck. There should also have been means provided for disconnecting any of the pumps in case of accident, as at present the only way in which that could be effected would be by stopping the engines and then removing the connecting-rod of the pump; again, the safety-valves are underneath the skylight, and there are no means provided for carrying off the waste steam; so that, should the skylight be shut, the only way by which the steam could escape would be up the engine room staircase; but as the designs were supplied from Calcutta, of course no responsibility can be attached to Messrs. Shand, Mason & Co., for any deficiency of arrangement.

ON VAST SINKINGS OF LAND ON THE NORTHERLY AND WESTERLY COASTS OF FRANCE AND SOUTH WESTERN COAST OF ENGLAND, WITHIN THE HISTORICAL PERIOD.

By R. A. Peacock, C.E., Jersey.

(*Continued from page* 57.)

CHAPTER XI.

Sinkings at the Scilly Isles. Probable Foundation for the Tradition of the Lionesse Country. On the identification of the Isle of Ictis. Sinkings on the South-West Coasts of England.

148. If I can succeed in convincing the reader that since the commencement of the Christian era, sinkings have taken place at the Scilly Isles, and between them and Cornwall, and at various places along all the English south-west coast, which lies west of the third meridian of west longitude; taking also into consideration the sinkings on the French coasts previously stated, he will probably be willing to believe that there was a sinking, or sinkings, which extended all the way across the English Channel. If I am right in affirming that no sufficient cause has been suggested for the neutrality in Chapter XIV., except that of the necessary neutrality of the sunken country, we shall, at any rate, have established a sinking for *more than* one-half the distance from Normandy to Cornwall. For the neutral space extended in all directions seaward, according to Poingdestre, for a distance of about 12 leagues (or about 30½ nautical miles) from each of the islands of Jersey, Guernsey, and Alderney. In my opinion the deeps in the centre of the English Channel are caused by unequal subsidences in the sea-bottom; and no time is so likely for these to have occurred as when subsidences were taking place on the French coasts opposite. On a future occasion I will attempt to prove that this must have been so. These deeps are, roughly speaking, about fifty per cent. deeper than the sea-bottom adjoining them.

149. We may be sure that the Scilly Isles afford proofs of considerable subsidences since the time of Diodorus. He says:—"Far beyond Lusitania [Portugal] very much tin is dug out of the islands of the ocean nearest to Iberia [Spain], which, from the tin, are named Cassiterides."* Strabo says:—"The Cassiterides are ten in number, and lie near each other in the ocean towards the north from the haven of the Artabi [who lived in the north-west of Spain]. One of them is desert, but the others are inhabited by men in black cloaks, clad in tunics reaching to the feet, girt about the breast, and walking with staves, thus resembling the Furies we see in tragic representations. They subsist by their cattle, leading for the most part a wandering life. Of the metals, they have tin and lead, which, with skins, they barter with the merchants for earthenware, salt, and brazen vessels. Formerly, the Phœnicians alone carried on this traffic from Gades [Cadiz], concealing the passage from every one; and when the Romans followed a certain ship-master, that they also might find the market, the ship-master, of jealousy, purposely ran his vessel upon a shoal, leading on those who followed him into the same destructive disaster. He himself escaped by means of a fragment of the ship, and received from the state the value of the cargo he had lost. The Romans, nevertheless, by frequent efforts, discovered the passage; and as soon as Publius Crassus, passing over to them, perceived that the metals were dug out at a little depth, and that the men were peaceably disposed, he declared it to those who already wished to traffic in this sea for profit, although the passage was longer than that to Britain."† On the contrary, the passage was and is a little *shorter*. Strabo says, also, on the authority of Posidonius, that "tin is not found upon the surface, as authors commonly relate, but that it is dug up; and that it is produced both in places among the barbarians who dwell beyond the Lusitanians, and in the islands Cassiterides; and that from the Britannic islands it is carried to Marseilles."‡—which is so far corroborative of Diodorus's passage about extracting tin in Cornwall (Art. 132). Strabo clearly identifies the Cassiterides with the Scilly Isles, by saying:—"Northward and opposite to the Artabri are the islands denominated Cassiterides, situated in the high seas, but under the same latitude as Britain."§ And D. P. Alexandrinus, who flourished in the time of Augustus, says, in his Geography, line 599, &c.:—"But beyond the sacred promontory [Cape St. Vincent] which they affirm is the extremity of Europe, in the islands Hesperides, where the source of tin is, the rich children of the illustrious Iberi dwell." The Scilly Isles being nearly north of the west coast of Spain, they must have been meant.

150. The Rev. W. Borlase, M.A., F.R.S., clearly proves* that "the slow advances and depredations of the sea will by no means suffice," to account for the great changes in the Scilly Isles since the times of the Romans. He says the present inhabitants are all new comers, and he nowhere found any remains of the Phœnician, Roman, or Grecian art, all the antiquities are of the rudest Druid times. "All the islands (several of which are now without cattle or inhabitants) by the remains of hedges, walls, foundations of many contiguous houses, and a great number of sepulchral barrows, show that they have been fully cultivated and inhabited. That they were inhabited by Britons is past all doubt, not only from their vicinity to England but from the Druid monuments." There are "several rude stone pillars, circles of stones erect† kist-vaens without number, rock-basins, tolmêns, all monuments common in Cornwall and Wales, and equal evidences of the antiquity, religion, and origin of the old inhabitants. They have also British names for their little islands, tenements, and creeks." He then inquires how the ancient inhabitants came to vanish? And states that two causes occurred to his mind while at Scilly, namely, "The manifest encroachments of the sea, and as manifest a subsidence of the land. . . . The continual advances which the sea makes on the low lands are obvious, and within the last thirty years have been very considerable." The italics in the following passages are by the present writer. "Again, the flats, which stretch from one island to another, are plain evidences of a former union subsisting between many now distinct islands. The flats between Trescau, Brêhar, and Sampson are quite dry at a spring tide, and men easily pass dry-shod from one island to another over sand banks, *where, on the shifting of the sands, walls, and ruins are frequently discovered*, on which at full sea there are 10 or 12 feet of water. But no circumstance can show the great alterations which have happened in the number and extent of these islands, more than this, he says, viz., that the isle of Scilly, from which the little cluster of these cyclades takes its name, is no more at present than a high rock of about a furlong over, whose cliffs hardly anything but "birds can mount, and whose barrenness would never suffer anything but sea birds to inhabit it." Walls and ruins are frequently to be seen on the shores, "foundations which were probably 6ft. above high water mark, now 10ft. under, which together make a difference as to the level of 16ft. *The land between Sampson and Trescau sunk at least* 16*ft.*, at a moderate computation. This subsidence must have been followed by a sudden inundation, and this inundation is likely not only to have destroyed a great part of the inhabitants, but to have terrified others who survived into a total desertion of their shattered islands. By this means, as I imagine, he says, "That considerable people who were the Aborigines, and carried on the tin trade with the Phœnicians, Greeks, and Romans were extirpated. . . . There are no mines to be seen in any of these islands, but only one lode (so we call our tin veins) in Trescau island, and the workings here are very inconsiderable and *not ancient*. It must therefore be matter "of wonder where the Phœnicians, Greeks, and Romans could have found such a plenty of that useful metal. Whatever resources they had from Cornwall, formerly reckoned probably among the Cassiterides [?] *great part of their tin must doubtless have come from these islands;* but where it was found is uncertain. Nothing now appears *above ground* which can satisfy such an inquiry. . . . The question then is, what is become of those mines? and how shall this question be answered but by confessing that *the land in which these mines were, is now sunk, and buried under the sea.* Tradition seems to confirm this, there being a strong persuasion in the western parts of Cornwall, that formerly there existed a large country between the Land's End and Scilly, now laid many fathoms under water. The particular arguments by which they support this tradition may be seen in Mr. Carew's "Survey of Cornwall," p. 3, and in the last edition of "Camden," p. 11. I have not access to Mr. Carew's work. Camden is quoted at the commencement of Art. 114. Mr. Borlase concludes as follows: "But though there are no evidences to be depended on of any ancient connection of the Land's End and Scilly, yet *that the cause of that inundation*, which destroyed much of these islands, *might reach also to the Cornish shores is extremely probable, there being several evidences of a like subsidence of the lands in Mount's Bay*. [See the abstract of his paper in Art. 113.] The principal anchoring place, called a lake [Guavas lake three miles west of the Mount] is now a haven or open harbour. The Mount, from its Cornish name, signifying a grey rock in the wood, but now at full tide it is half a mile in the sea, and not a tree near it." The sinkings of the Scilly isles are not necessarily limited to so little as 16ft., because the walls which are now covered 10 or 12ft. at high water may once, before they sunk, have been *many feet* above high water.

* Diodorus, Paris edition, Simon Colinæus, 1501, p. 192.
† Strabo, book iii., chap. 5, sec. 11.
‡ Strabo, book iii., chap 2, sec. 9.
§ Strabo, book ii., chap. 5, sec. 15.

* Phil. Trans. R.S., 1753 Vol. 10, p. 324, &c.
† The circles of stones are not necessarily British (and some still exist) many circles are in the Channel Islands, which were not British until the year 1066.

151. Dr. Paris, the supposed author of the volume mentioned in the foot note,* says at p. 92, that the Scilly Isles are said to be mentioned by D. Siculus, Strabo, and Solinus. They must, however, have undergone some material revolution since the age of these writers, for we fail in every attempt to reconcile their present state with the description which they have transmitted to us, and what is very unaccountable, not a vestige of any ancient mine can be discovered in the islands, except in one part of Trescau, and these remains are so limited that they rather give an idea of an attempt at discovery than of extensive and permanent mining."

Dr. Paris, to whom the idea of modern subsidence seems never to have occurred, can only account for the great traffic in tin from the Cassiterides by supposing that under that name St. Just on the main-land must have been included. He proceeds, "We are strongly inclined to believe that the tin of those days came, in part at least, from the opposite coast of St. Just, but of this we shall hereafter speak more fully." And then at p. 141, he says, "St. Just has been considered by Mr. Carne, and not without probability, as having constituted the principal portion of what "was formerly known under the name of the Cassiterides."

152. At p. 92, &c., he says: "In the time of Strabo we learn that the number of these islands did not exceed ten, whereas at present they are upwards of one hundred and forty, but of which the following only are inhabited, viz., St. Mary's, St. Agnes, St. Martin's, Trescou, Bryor, and Sampson. It is curious that the name of the cluster should have been derived from one of the smallest islets (Scilly), whose surface does not exceed an acre." He then says that St. Mary's contains 1,600 acres and nearly a thousand inhabitants, the remaining islets about another thousand inhabitants. From the census of 1851 it appears that the population of Isle St. Mary was then 1,668, Tresco 416, St. Martin 211, St. Agnes 204, Bryher 118, Sampson 10; total 2,627 in the six inhabited islands.

Mr. Carnes' and Dr. Paris's argument, that because there is no mining (worth naming) in the Scilly Isles now, that we must therefore consider part of the main-land at and about St. Just as having been referred to by the ancients under the name of the "Cassiterides," is clearly inadmissible. Strabo's and the Rev. W. Borlase's testimonies, already quoted, distinctly prove that there is no necessity whatever to adopt any such improbable and inaccurate views. It is evident the Isles have sunk, and the ancient mines are lost, and that tin was also got in Cornwall.

154. Camden says† the Scilly Isles are called by Antoninus, *Sigdeles;* by Sulpitius Severus (an ecclesiastical and historical writer, who died A.D. 420), *Sillinæ;* by Solinus, *Silures;* by Dionysius Alexandriuus, *Hesperides;* by Festus Avienus (who lived in the latter part of the fourth century), *Ostrymnides;* by several Greek writers, including Diodorus, and by Pliny the elder, *Cassiterides;*‡ and Strabo has told us§ that Publius Crassus "saw that the metals were dug out at a little depth" in the Cassiterides; this was about 57 B.C. So that these Isles were well known to the ancients.

155. In viewing the whole scenery of the stern western coast of Cornwall, "it is impossible," says De Luc, "not to be struck with the idea, that the bed of the sea is the effect of a vast subsidence, in which the strata were broken off in the edge of what, by the retreat of the sea towards the sunken part, became a continent; the many small islands, or rocks of granite, appear to be the memorials of the land's abridgment, being evidently parts of the sunken strata remaining more elevated than the rest." ‖ That is to say, in De Luc's opinion, the Lionesse country may really have existed.

ON THE IDENTIFICATION OF THE ISLE OF ICTIS.

156. We need not necessarily go back as far as the time of Diodorus for the origin of the Cornish name of St. Michael's Mount—"Carreg Coedh yn clos," *i.e.*, Rock of the wood in the enclosure.¶ William Camden, who was born in 1550, and died 9th November, 1623, proves that the Cornish language had not become quite extinct even so lately as in his time. He says, speaking of the *Damnonii*, or inhabitants of Devon and Cornwall:—"The old Cornish tongue is almost quite driven out of the country, being spoken only by the vulgar in two or three parishes at the Land's End, and they, too, understand the English. In other parts little or nothing is known of it. 'Tis a good while since that only two men could write it; one of them, no scholar nor grammarian, was blind with age."* *

In the "Penny Eucyclopædia," too, edition 1837, heading "Cornwall," we learn that:—"In the reign of Edward VI. a new revolt broke out connected with the religious revolution of that period.† † The Cornish men took up arms to sustain the Roman Catholic church, and besieged Exeter; but were forced to raise the siege, and at last, though not without difficulty, were subdued. The change of the religious institutions of the country led to the change of the common language of Cornwall; the people, for the most part of British descent, with comparatively few Saxons settled amongst them, had retained a language of their own, a dialect of the Celtic." [Camden gives the Lord's Prayer in Cornish, Welsh, and Armoric respectively, each of which languages resembles the others.*] "The introduction of the English church service paved the way for its gradual decline. When Carew published his 'Survey of Cornwall,' in 1602, it was going fast into disuse. 'The English speech,' says he, 'doth still encroach upon it, and hath driven the same into the uttermost skirts of the shire. Most of the inhabitants can speak no word of Cornish, but very few are ignorant of English, and yet some so affect their own, as to a stranger they will not speak English; for if, meeting them by chance, you inquire the way, or any such matter, your answer shall be, *Mee a navidra couzna Sawzneck, i.e.*, I can speak no Saxonage. In the reign of Charles I. [1625 to 1649] some aged people near Penryn were quite ignorant of the English language. In the early part of the last century [the eighteenth] Cornish was still spoken by the fishermen and market women near the extreme southern point of the country. At present this ancient tongue is the study of the scholar and antiquary. A few MSS. in it are extant, the most remarkoble of which are some interludes, partly written in the fifteenth century.'"

157. *The Anglo-Saxons in England.*—It will now be convenient for various purposes connected with our subject to give a slight sketch, with dates, of a few of the principal events connected with this people. When the Saxons first began to have a name in the world they lived in the Cimbrica Chersonesus, which we now call Denmark; where they are settled by Ptolemy, who is the first that makes mention of them.† About the middle of the fourth century all the people from the Rhine to the northern extremity of Jutland, were called Saxons. The Jutes or Getes also lived in Jutland, and they with the Angles and Saxons afterwards re-peopled the better portion of Britain.‡ Camden places the Angles on the north-west of the Rhine in the first century, in Westphalia, &c.; from which Gibbon and Lingard do not differ. In 449, Hengist and Horsa came from Oldenburg, the north-western part of Hanover, and the north of Holland, by request of Vortigern, the most powerful of the several contemporaneous British kings, to assist him to repel the Picts and Scots, and for six years they served him with fidelity. This is the very earliest period at which the Saxon name *Mychel-stop,*§ or Michael's-place could have been given to Mount St. Michael, but the date of its being first so named is probably later. We find that the third kingdom of the Heptarchy, namely that of the *West Saxons*, which finally swallowed up all the rest, was established by Cedric after a great battle at Charford in 519, and it comprised Hampshire and Berkshire, and, within less than two centuries after all the other counties on their west. Cedric associated his son Kenric with him in the regal dignity, and bestowed upon his nephews the subordinate sovereignty of the Isles of Wight, and died in 534.‖ (The Isle of Wight will be referred to again hereafter more than once.) Ina, a subsequent king of the West Saxons, at the head of a resistless army added in 710 several districts to his western provinces, and expelled after long struggles, Geraint, king of Cornwall. King Athelstan also subdued Cornwall at the beginning of the ninth century. *Danegelt*, was a tax collected to defend England against the Danes, or to pay them. Mount St. Michael was called *Dinsol.*¶ (King Edward the Confessor, who reigned from 1042 to January 5th, 1066, when he died and was succeeded by Harold), gave in 1044 to an abbey of Benedictines on St. Michael's Mount, founded previously;* * the Mount and all its appendages. And Robert, Earl of Moriton, annexed [the whole or a part of the Mount and its appendages] to God and the Church of St. Michel de periculo maris in Normandy, about the year 1085. It appears very probable that the Cornish Mount was first called Mount Saint Michael, after its chief, the Norman Monastery of Mont St. Michel, at this last date.

158. In the important passage now to be quoted from "Domesday Book" I have translated the words "nunquam geldaverunt" as signifying, 'never paid the Danish tax,' which is their correct signification. Places of worship were exempt from this tax.

"DOMESDAY BOOK."

159. At the end of "Domesday Book," vol. 2, is annexed a cotemporaneous memorandum in abbreviated Latin (in which the book itself is wholly written) as follows:—"In the 1086th year of the Lord's incarnation, being the twentieth year of the kingdom of William, this description was made. Not only through these three counties,† † but also through the others," *i.e.* other counties.

This authentically fixes the date. And I will try to satisfy the reader that at the date named St. Michael's Mount was not yet an island, but was joined to the mainland of Cornwall.

I am fortunate enough to possess a fac-simile photographic copy of the Cornwall part (which calls itself "Cornvalge") of "Domesday Book," printed

* "Guide to Mount's Bay and the Land's End," by a Physician. 1824.
† "Britannia," edition 1722, first published 1586.
‡ From κασσίτερος, tin. § Art. 205.
‖ "Guide to Mount's Bay, &c.," p. 89.
¶ See Mr. Métivier's Letter, Aug. 4, 1866.
* * "Britannia," edition 1722, p. 8.
† Edward VI. reigned from 1547 to 1553.

* "Britannia," 1722, p. 8.
† "Camd. Brit.," p. clvi.
‡ Lingard, "Hist. England," vol. 1, p. 86.
§ "Magna Britannica," vol. i., p. 309. And Camden's map.
‖ See "Lingard's Hist.," vol. i., p. 96, 124, &c. He quotes Henry of Huntingdon and the *Saxon Chronicle.*
¶ "Magna Britannica," vol. i., p. 309.
* * "Penny Cyclop.," 1837, Art. Cornwall.
† † Essex, Norfolk, and Suffolk, which occupy vol. 2.

at the Ordnance Map Office, Southampton, in 1861, from page 2 of which the following is a correct translation:—

"The Land of Saint Michael.

"Keiwal holds the church of St. Michael. Brismar was holding it in the reign of King Edward.* There are 2 hides which never paid the Danish tax. The land is 8 carucates. There is 1 carucate with 1 villan†, and two bordarii,‡ and 10 acres of pasture. Value, 20 shillings. Of these 2 hides Earl Moriton took away 1 hide, value 20 shillings."

At p. xi. of Domosday Book there appear in the descriptive list of the many estates of Earl Moriton corresponding particulars of the 1 hide which he had taken away.

Now, in the first place, "Domesday Book" gives no reason whatever to suppose that St. Michael's Mount was an *Island* (neither does the Saxon name, Michael's Place, in Art. 157). But there is a good deal of negative evidence to the contrary. Firstly, on page 3, "The land of the Church of Tavestoch" is mentioned exactly in the same way as "The land of Saint Michael" above; though the former is 15 miles from the sea—there being no mention of "Island" in either case. And in every case while "annoting" those holding possessions ("tenentes") in "Cornoalgia," as—"King William, the Bishop of Execestre, the Church of Tauestoch, the Churches of certain Saints, Earl Moriton, Judhail de Totenais, Goscelmus"—there is an entire absence of any mention of Island or Islands on any of the coasts of Cornwall, just as if there had been then no Islands on the coast of Cornwall of sufficient extent to be worthy of mention. Secondly, it is the custom in "Domesday Book," *when a place is an island to call it so*. For example, in vol. 1, folio 75, "Dorsete" (Dorset) we have:—

"The land of the King.

"The King holds the island which is called Porland. King Edward held it in his life."

And, again, in Domesday, vol. 1, fol. 396:—

"Hantescire" (Hampshire).

"These lands below written lie in the Isle of Wit" (Wight)."

But, thirdly, which is the strongest proof of any, the Mount could not have been an island at the date of 1086, because it contained eight times as much land as it does now. The truth, Sir Henry Ellis says, seems to be that a hide, a yardland, a knight's fee, &c., contained no certain number of acres, but varied in different places at different times. General Introduction p. 34, there are "four virgates in each hide, and thirty acres to make a virgate." At p. 51, by the Statutum de Admensuratione Terrarum $5\frac{1}{2}$ yards of the Ulna regis or yard of 3 feet, were to make a perch and (p. 50) the elementary acre was 40 perches by 4 perches. At p. 47 it is stated that the hide varied according to different places; but that was afterwards. For we find, at p. 47, Bishop Kennett says, in 1169, "a hide of land at Chesterton contained 64 acres." But, taking the smallest of the following carucates, the 8 carucates would have amounted to 480 acres:—

Ibid.	Carucate temp. Richard I.	60	acres.
	Ditto	100	"
	Ditto Edward I.	180	"
	Ditto 32 Edward III. (Oxon)	112	"
	Ditto Ditto Middleton	150	"

The hide is generally supposed to have been equal to 120 acres. It was the measure of land in the Confessor's reign, the carucate that to which it was reduced by the Conqueror's new standard. The carucate was as much arable land as could be managed with one plough and the beasts belonging thereto in a year; having meadow, pasture, and houses for the householders, and cattle belonging to it.

Now Sir Charles Lyell gives no less than three views of St. Michael's Mount. Two of them are taken looking south from the coast of Cornwall, one at high and the other at low water. The third view is taken about from Penzance, looking east. He also describes it as consisting chiefly of granite, with some slate rock, and 195ft. high, with precipitous sides,§ which his three sketches corroborate, as does the shading on the Ordnance Map. And it is quite clear that so far from there being now eight carucates, *i. e.*, several hundred acres of arable land, *there can hardly be a single acre capable of being ploughed, because the ground is too steep.* Taking the hide at 120 acres, the whole area of the mount (two hides) would be 240 acres. At present the whole area is usually stated at 70 acres,|| but by the Ordnance Map 1839, which is probably correct, it measures barely 30 acres. So that there are 210 acres missing, how can we account for them except by supposing that the Mount extended further, perhaps in every direction? There can have been no clerical error, for the land of St. Michael is stated to have been two hides, and of each hide particulars are given, and also particulars of the hide taken away by Earl Moriton. Of the first hide we learn details, namely, that there were eight carucates, or as much as eight ploughs could cultivate, one carucate with one villan or villager, two bordarii with their cottages, and probably each a garden, besides ten acres of pasture. The whole of which was worth annually 20 shillings, equal to £30 at the present day. Of the two hides Earl Moriton took the other, which was also worth 20 shillings, or £30 of present money, for the purpose, as we have learnt from another source, of giving it to the Monastery of Mont St. Michel, in Normandy.

* The Confessor. † Villani, inhabitants of villages.
‡ Dwellers near the manor house, or perhaps cottagers.
§ "Principles of Geology," 1867, p. 539-541.
|| See Census, 1851, vol. 1, Div. 5, p. 64, and "Penny Cyclop." 1837.

160. The great care that was taken to procure correct and authentic information for the survey, precludes the belief that there can have been any material error in the measurement. Sir Henry Ellis informs us in General Introduction, p. 6, that "for the adjusting of this survey, certain commissioners called the King's Justiciaries, were appointed. Those for the Midland Counties at least were the then Bishops of Lincoln, the Earl of Buckingham, Henry de Ferrers, and Adam the brother of Eudo Dapifer, "who probably associated to them some principal person on each shire." And he quotes a curious document showing that the information was given *on oath*. At p. vii., the Inquisitors, it appears, upon the oaths of the Sheriffs, the Lords of each Manor, the Presbyters of every Church, the Reves of every Hundred, the Bailiffs, and six villans of every village, were to inquire into all the necessary particulars. Was not this taking all possible means to obtain correct information? Is it credible that the Mount should have been said to have contained two hides, if it only contained, as at present, one-fourth part of a hide?

We have thus ascertained the fact, that during the last eight centuries, 210 acres, less a small amount, suppose, washed away by the tides, have disappeared, and have to be accounted for. For it would be more trifling to suppose that the Domesday survey made the Mount eight times as extensive as its real size. If we were to take the largest measure of a carucate our eight carucates of arable land would amount to no less than 1,440 acres. Whereas at present there can hardly be a single acre of land in the whole islet, capable of being ploughed, for it is too steep and rocky!

161. The following accounts of a peculiar and very destructive *inundation* (shall we call it?) are not a little remarkable, occurring as it did, thirteen years *after* the Domesday Survey. Florence of Worcester says: "On the third day of the nones of November, 1099, the sea came out upon the shore, and buried towns and men very many, and oxen and sheep innumerable." The still more quaint and equally interesting Saxon Chronicle for that year, corroborates Florence to the very day, for the third day of the nones of November is the 11th, by saying, "On St. Martin's mass day, the 11th of November, sprung up so much of the sea flood, and so myckle harm did, as no man minded that it ever afore did, and *there was the ylk day a new moon*.* This is speaking very much to the purpose The catastrophes cannot be referred to the great height of the tide, for *the highest spring tides do not occur until several tides after the new moon*, and the 11th of November is several weeks after the Equinox. Have we any choice, therefore, since the average sea-level does not alter, except to believe that the ground sunk, and so enabled the waters to come upon the shore, and to bury very many towns and men, and innumerable oxen and sheep, and to do an unprecedented amount of harm?

162. December, 1866, Mr. Pengelly gave me a printed copy of his paper, of which I am a great admirer, "On the submerged forests of Torbay," and he also lent me his important M.SS., "On the insulation of St. Michael's Mount in Cornwall," and stated that he should feel obliged if I would treat it as freely as if printed, and that I was to use any part of it for any purpose for which it would suit. There was only one way of responding to so much voluntary kindness and liberality, and that was to beg of him to use the same freedom with all publications and M.SS of the present writer, which might come into his hands. This was immediately done, and two numbers of The Artizan, containing portions of what now appears in this volume, were sent to him, as well as a MS. copy of another portion. And as soon as this chapter shall have been written out, a MS. copy will be made and sent for his acceptance,† since it is obvious that a free intercommunication between gentlemen who have studied the same subject, and who care for nothing but the truth, as in the present case, must be of great advantage.

163. Mr. Pengelly states, in "Submerged Forests of Torbay," that "Florence of Worcester (which he corrects in a letter to William of Worcester, 1478) expressly asserts that St. Michael's Mount was formerly five or six miles from the sea [the ancient coast line on the map is drawn accordingly], and enclosed with a very thick wood, and, therefore, in British, 'Carreg lug en Kug,' 'Le Hore Rock, in the Wodd.'" And he gives a reference as in the foot-note.‡ In his MS. (p. 7), he arrives at the following conclusion, in which I entirely agree with him, as to St. Michael's Mount:—"The ancient designation then does betoken a change in the geography of the district—a change not only within the human period, but since Cornwall was occupied by a people who spoke the language which was tardily supplanted by the Anglo-Saxon." From his double reason "that nineteen hundred years ago the Mount was not merely insulated, but that it possessed a harbour," I dissent, for the reasons contained in the previous part of this chapter, and elsewhere in the present volume. His two reasons

* Florence and the Chronicle are both quoted from "Milner's Gallery of Nature," 1846, p. 387. See also "Principles of Geology," 1867, p. 387.
† Sent to Mr. Pengelly, Jan. 26, 1867.
‡ "Trans. Roy. Geo. Soc. of Cornwall," vol. ii., p. 134.

are, first, that a certain rocky ledge, now known by the name "Hogus," which lies parallel and adjacent to the Causeway, leading at low water from Marazion to the "Mount," is *old* Scandinavian, and signifies "a rock in or near a wood, adjacent to water, and used for sacrificial purposes." From which I think I am correct) he infers that the word being "old" Scandinavian, the ledge must have been laid bare as early as Diodorus's time. Mr. George Métivier, of Guernsey, who has again and again given me ample reasou to believe in his great philological knowledge, and his willingness to communicate it, says, "*Hogus* (in Guernsey *hougue*, French *hogue*, noo-Latin *hoga*) sometimes denotes a stony or quarriable knoll. *Liber Sharburnensis* apud Spelman, says:—'Idem Canntus* dedit prædicto Edwino Sharburnensi. . . . . quemdam collem et *Hogum* petrosum.'" There is also, in St. Peter's parish, Jersey, a good house called la *Hogue*, near a mass of quarriable crystalline clay-slate. From all which it may be inferred that if "Hogus" is middle aged, it is also modern, and therefore gives us no authority whatever to believe that the Mount was insulated as early as Diodorus's time. Mr. Pengelly's second reason (see his M.S., p. 10, 11), if derived from Diodorus's passage, given in Art. 132, and from Dr. Barham's view, who is said by Sir C. Lyell to have "shown that the Ictis of Diodorus not only answers geographically to St. Michael's Mount, but is just such a promontory as would have been selected by foreign traders as well adapted for defence."† Now, on the other hand, even if the coast had remained unaltered ever since Diodorus's time—a large and unjustifiable supposition—the Roman tin-transporting ships need not by any means have been confined to St. Michael's Mount as a harbour, because, as the Rev. W. Borlase well observes (Art. 150), Guavas Lake is the principal anchoring place. And, consequently, we ought in fairness to believe that the exportation of tin cannot have taken place wholly or even chiefly, from St. Michael's Mount. And these considerations are a heavy blow and a great discouragement to the belief that the Mount is Ictis.

(To be continued.)

* Canute reigned 1014—1030.
† "Principle of Geology," 1867, p. 512.

THE LAW OF PROGRESS AND THE STEAM ENGINE.

By Thomas Ewbank, New York.

Knowledge is increasing, but nowhere has society advanced to the recognition of progress as a primary principle of natural law. Of this, people of old knew nothing, and hence their aspirations never rose above the current conditions of things. It is much the same still. Monarchs strive to reconcile their subjects to effete systems of government. Adherence to old formulas is the law, and obedience held forth as a virtue. Of the industrial arts there are none from which inquiry into old processes has not been held back by absence of ambition to excel and the apophthegm of the supine, "Let well alone." That which people are satisfied with, they are in no haste to abandon.

I know not to what else to ascribe the persistont ignoring by engineers of two significant theorems in the economy of steam, viz., that its virtue as a motive agent is undiminished, intact to the moment of liquefaction, and that more power may be had from its collapsion into water than from its swelling energy as an elastic fluid. An invention that is, and promises through the future to be, one of the crowning glories of the arts, should, so far from exhibiting serious imperfections, command in every feature and as a whole the highest praise of genius. Not another can be named so essentially allied to advancing civilisation, to agriculture, manufactures, mining, and commerce; not one with greater claims on the attention of the most gifted of mechanicians. Not that efforts to improve the steam engine have been lacking; far from it, for it has undergone numberless forms and modifications. Like fashions in dress and dry-goods, almost every season has brought out fresh ones. But, on the whole, they have been rather superficial than profound, external than internal. More thought has been given to the skeleton—to forms, arrangements, and movements of the limbs—than to an economical and perfect application of the animating fluid. In all it has been lavishly expended, and wasted in most to an extent surpassing that of any staple material of manufacture, a waste that would bankrupt every factory in existence. Were it not near as much as represented, it is enough, and ought to be more than enough, to awaken inquiry even in the apathetic. But there are those who think the popular motor cannot be much further improved; that there is little or no room for improvement. Just so people thought of machines now obsolete; and quite as natural is it for those as ignorant of nature's series of ascending lessons as children of subjects to which the alphabet and spelling-book are introductory, to think so now. As respects a few modern mechanisms, the opinion may be true; but only for the time being, for there is no reason to infer that artificial devices will ever cease to be superseded or improved. Strange as this may sound, so far from being irrational or out of rule, it is in accord with the economy of creation and our own organisation. There is something in us that, once awakened, craves for progress, and cannot be satisfied without it. However far we may go, howover great our achievoments, this urges us onward to groater ones. Things that appeared miracles in former times have become everyday facts, and we are filling up a new list. Hitherto the world of intelloct has been in a great measure torpid. Our times are but tho beginning of mental activity. We live too near the infant period of our species to have other than mere glimmerings of what the arts are to grow up to; enough, however, to convince us that were it not for the progressive principle, our destiny could be little different from that of the brutes. We must either advance or retrograde till the higher faculties sink into the lowest.

I suppose few persons are aware of the *sui generis* fact that more power may be got from steam escaping from engines than it gives out within them, and fewer still who believe it. The incredulous say the fact, if it be one, could not have escaped the notice of early engineers, and their numerous and able successors. Suppose it did not; they evidently did not turn it to account. Others remark that it would be strange if this wonder-working instrument, which has given an unprecedented stimulus to the arts, multiplied and cheapened thoir products, and vastly improved every species of producing mechanisms, has not itself kept pace with them. Not at all. No human device is, or ever can be, born perfect. Like natural organisms, it must grow; and the more important and complicated, the slower its growth. Whatever admirers of the engine may think, as long as half its power is unproductive it can be but half developed. Its defects are accounted for by its comparatively recent origin and its great and novel character as a generator and transmitter of force—as a mover and even maker of machines. It was out of the category of all previous inventions. It took the world the greater part of a century to appreciate it. Requiring more than common minds to develope, the knowledge of its principles and construction has been confined to a limited number of operators. Outside of them people yet know little of it; but the times are changing all this. In common with other things it will become open to, and be benefitted by, investigation and criticism. A mechanical power, the steam engine, is the product of that which is the source of all power, and hence, as long as knowledge increases "among men" (to use Smithson's formula), its fruits must increase both in quantity and quality, and they do. We are not satisfied with devices current fifty years ago. They could not meet our present wants, and just as we feel toward the condition of things then, our successors, fifty years hence, will probably feel towards our times and us. To all the machinery of to-day they will not certainly be reconciled. But some will ask, how can mechanism be continually rendered more efficient and its applications extended? Without dwelling on minor points, on forms and motions, or even principles of motion, let it be remembered that new elements and materials of the arts are being constantly brought to light, and among them metals possessing higher qualities than any familiar to us, and provided in equal abundance. That iron, after preparing us for their introduction and management, is destined to be superseded, to a great extent, by them can no longer be doubtod. Take one now coming into use—aluminium—as an example, not one-third the weight of iron, rivalling it in tenacity and other properties, little, if at all, subject to oxydation by atmospheric exposure, and consequently vastly more enduring. Imagine the change in the entire circle of the arts when it and kindred ones are in as much demand for general machinery, engineering purposes, and hardware as iron is now. As for steam, it has opened on the world an era of progress, and is destined to continue a leading characteristic of it.

Mark the difference between past times and the present—between us and leading nations of old. The arts of India and of the East generally are what they were thousands of years ago, and—an inevitable consequence—so is the social and political status of the people. With them, machines once established were never altered; with us, to make them do better work and more of it, or to replace them by others, is becoming the rule—a national habit. (See recent Patent-office Reports.) To some minds there may be nothing in this to excite special attention; yet, in reality, it is of equal significance and import to the future as any of the great onward movements of the day. It is the very pith and marrow of progress in the arts, and progress in them is progress in all other matters. On this planet man is the work of God, and evolution of steam power is by far the noblest work of man. In its present and prospective effects on the physical, intellectual, and moral advancement of our species, there is nothing that comes near it. Of all things its expenditure should accord with the highest working standard.

RAILWAYS IN AND TO INDIA.

There is no man who, from first to last, has done more good work for the promotion of railway communication in India, than Mr. W. P. Andrew. From the time when, more than twenty years ago, he wrote a remarkable pamphlet, far in advance of the times, under the modest *nom de plume* of an "Old Indian Postmaster," up to the present day, he has laboured most assiduously, and has devoted no common energy and ability to the furtherance of this great object. On the general subject of Indian railways, or any particular points connected with it, no man is listened to

with more respect. We were glad, therefore, to see him the other day coming frankly and honestly forward to vindicate in the columns of the *Times* the Indian Government with respect to the good faith which it had always observed in the matter of its guarantees. "I have been a party to no less than four contracts with the Secretary of State for India in Council conferring the advantages of the guarantee of the Government of India on the several undertakings with which I am connected, and in no instance has there been for a moment the slightest cavil as to the amount of interest due from Government, or a day's delay in the payment of the amount. Even during the height of mutiny, the good faith and punctuality, for which the Government of India has ever been distinguished, were as manifest as in ordinary times." This is no more than ought to be said about the good faith of the Indian Government, but it is well that it should be said on such high authority. After this, Mr. Andrew goes on to explain in a very lucid manner the real character of Government guarantees in India, and the precise powers which they confer on the Government granting them. On this the *Times* observes, that "the evil incidental to Indian guarantees lies in the readiness of the Indian Government to grant them. The moment any of the five per cent enterprises creep up above par, a fresh supply is threatened, and thus the previous investors never see their stocks attain a proper position in the market. But for this constant swamping of any premium to which they may reach, they would probably before this have acquired a popularity in India that might have tempted native capital to flow into them, a result which has thus far been remarkably absent. Certainly, if the debt is, as Mr. Andrew suggests, to be looked upon as almost equally sacred with the liability to the English fundholder, it would be well that Parliament should at once assume a greater supervision over it, since in that case, while there is the present jealousy of affording the slightest aid to English lines, we may assume there would also be some disposition to restrain the extension of our credit commitments for a territory so distant. But the fact is that there is not at present any readiness on the part of the Indian Government to guarantee any experiments of the kind, and that as far as we understand the matter, Parliament has really nothing to do with it. If an imperial guarantee were given, of course parliamentary supervision would be called for; but as it is, the supervision of the Secretary of State for India in Council, which is vigilantly exercised, is all that is required."

Turning to another and perhaps more important subject, we may say that we observe with much satisfaction that Mr. Andrew is again moving—and he is one of those men who seldom move in such cases without eventual success—for the promotion of the great national scheme of the Euphrates Valley Railway. This is a project the immense advantages of which far transcend either the difficulty or the cost of execution. To open out a new and more expeditious "overland" route to India would seem to be a gigantic undertaking; but the impediments offered to it are small, and the facilities, on the other hand, such as to encourage every reasonable expectation of success in all the different aspects in which it can be regarded—political, military, commercial, and financial. On the present occasion we merely glance at this important subject. But it is one which we shall keep steadily before us; and to which we shall return from time to time, as the scheme appears to develope itself. It cannot be in better hands. Napoleon said that he had faith only in successful men. Mr. Andrew has been eminently successful. The schemes which he has worked out have prospered; and this, the greatest scheme of all to which he has directed his energies, will, we believe, be eventually accomplished.—From the *Homeward Mail.*

WROUGHT IRON SLEEPERS BY MESSRS. SHANKS AND NELSON.

The use of cast or wrought iron sleepers for Indian railways seems to be very expedient, owing to the great scarcity and price of teak, and the failure of nearly every other kind of timber used for them.

With regard to this sleeper, it has a bearing surface of $8\frac{1}{2}$ sq. ft. per linear yard of single line, and for that reason may be superior to some other iron sleepers; as Barlow's cast iron, which has 5·6 sq. ft.; Messrs. Livesey and Edwards' cast iron, which has 5·7 sq. ft.; their wrought iron, which has 5·6 sq. ft.; Messrs. Griffin's longitudinal cast iron, which has 5·3 sq. ft. when laid 1ft. apart; their cast iron, which is 5·6 sq. ft.; or Greaves' bowl sleeper, which is $6\frac{1}{4}$ sq. ft.

As regards weight, when the materials have to be sent to a distant country, the freight increases the cost considerably, and these sleepers cost, when laid in India, £1,252 per mile of single line, as compared with Messrs. Livesey and Edwards' wrought iron, which would be £833, and their cast iron, £809; Messrs. Griffin's cast iron, at £925 10s., and their cast iron for longitudinal £833 10s. for a bridge rail; Messrs. Greaves' bowl sleepers at £1,144. This is taking the freight in each case at £2 per per ton, and the cost of laying a yard of single line in India at 12 annas, or 1s. 6d.

It thus appears, that this proposed kind of permanent way is more expensive than the other ones mentioned, and it is merely a question whether its larger bearing surface compensates in any measure for this extra cost, or if the bearing of the others is not sufficient for general traffic. In Messrs. Livesey and Edwards' wrought iron sleeper, the rail being suspended, does not wear so much as when supported on chairs or sleepers; and so when afterwards reversed, the other table is quite uninjured, which is a great desideratum abroad, where as much wear is required from a rail as can be obtained. It also appears to make a very smooth, elastic road.

The great objection to all cast iron sleepers is, that they will break under a passing load if not well packed, and this cannot always be insured from the native platelayers in India. Sand ballast also, which is requisite for all cast iron sleepers, can only be procured near the coast, or from some of the river beds, and great breakage is certain to occur, especially in the cuttings, when other ballast is used. In case of a train running off the line, it is not such wholesale destruction with wrought iron sleepers, as with cast iron.

METROPOLITAN DISTRICT RAILWAY.

The railway now in course of construction is a very important link, connecting together different railways having their termini in London. It commences at Kensington, meeting there the Western Extension of the Metropolitan Railway from Paddington; from thence it continues in an easterly direction through Brompton and Chelsea, passing about a quarter of a mile to the south of the former International Exhibition, then under Sloane-square, close to the south of Chester-square, to opposite the Victoria Station of the London, Chatham, and Dover Railway. It crosses under Victoria-street and continues near the northern side of it for some distance, then turning away it crosses the Broadway at Westminster, and passes down the north side of Tothill-street to Westminster Hospital, passing close between it and St. Margaret's church. At the N.W. corner of Westminster Bridge it enters in the Thames Embankment, and there will be a covered way from the station there, to the Houses of Parliament. It will follow along the Thames Embankment to Blackfriar's Bridge, then onward by Earl-street, Cannon-street to Trinity-square, near the Tower. Here it meets the Eastern Extension of the Metropolitan Railway. The length will be $6\frac{1}{2}$ miles, and it completes what is called the Inner Circle. It is joined to the West London line at Brompton and Kensington by two branches, which are two miles in length. This gives it a communication with the Great Western, London and North Western, South Western, Brighton and South Coast, London, Chatham and Dover, and Crystal Palace lines.

There will be exchange stations at Kensington, Brompton, Richmond and Victoria, Charing Cross, and Blackfriars, and also other stations at Cromwell-road, Sloane-square, Broadway (Westminster), Somerset House, Cannon-street, Tower, and Trinity-square.

The engineers for this line are Messrs. J. Fowler and Marr Johnson, and the contractors are Nessrs. Kelk, Waring Bros. and Lucas.

The Act of Parliament for its construction was passed in 1864, and the company completely organised in February, 1865. A very considerable portion of the land between Westminster and Kensington has been obtained, and the works are now in active progress. It is expected that the part of the line between Kensington and Westminster will be completed by the end of the year.

INSOLVENT RAILWAY COMPANIES.

The recent proceedings in the case of the debenture holders of the London, Chatham, and Dover Railway Company, which exhibited the plain fact that holders of debenture stock are practically entitled to no more privileges than preference shareholders, and thus proved the law to be in a most unsatisfactory state, have induced the Government to submit to Parliament a new "Railway Companies' Arrangement Bill," of which the following is the substance:—This bill (proposed by the ex-Chairman of the Board of Trade, Sir Stafford Northcote) is to come into operation in any one of the three following cases, viz.: Where a railway company fails for one month to make a payment due upon any debenture; or where the company's goods are seized under a writ of execution; or where a company discontinues for two months the use of public traffic of their undertaking. The persons who may set in motion the machinery provided by the bill are also three: One-fifth in value of the debenture holders, or of any class of the preference shareholders, or of the other shareholders. The special inspectors whom the Board of Trade may appoint (after considering objections from directors to shareholders) are to investigate the transactions and condition of the company. They are to have power to obtain the opinion of the Court of Chancery in a summary way upon questions that may arise. If they think fit to make or approve any proposition, the assent of three-fifths in value of any class of debenture

or shareholders is to bind all the class. The inspectors, on the conclusion of the investigation, shall, if they think fit, frame and report to the Board of Trade a scheme for such an arrangement as appears to them most equitable and expedient in relation to all classes of persons interested and to the public, and which may include the winding-up of the affairs and sale of the property. If the scheme, not including such winding-up and sale, is assented to by all classes of debenture holders and shareholders, and not objected to by any lessor of any part of the undertaking, and provision is made for the satisfaction of the debts, then the scheme may be carried into effect by order in Council: but if it includes such winding-up and sale, or if it is not so assented to, it will have no operation unless confirmed by Parliament. If the bill for its confirmation be opposed, it may be committed to a body representing both Houses, constituted and acting as standing orders of the Houses direct. A clause provides that, after notice in the *Gazette* of the appointment of the special inspectors, the goods and effects of the company may not, without leave of the inspectors, be seized under any writ of examination issued against the company.

This bill, although it lessens the present anomalies, and is calculated to confer some benefit and relief on the legitimate interests of debenture holders, cannot, in our opinion, be expected to work satisfactorily in practice, as the preliminary conditions to its being put into execution, are too numerous, and the expenses it entails far too heavy to warrant the assumption that its object will be effectively realised in ordinary cases. At all events, too much scope is allowed to the vexatious influence of interests at variance with those of *bonâ fide* creditors.

ROBBINS' GAS AND WATER JOINT.

These joints manufactured by Messrs. T. G. Gaylord, of Newport, Ky., U.S., have lately been adopted by the Cincinnati Waterworks, and seem to have been found very satisfactory. We here give an illustration of these joints. Fig. 1 is a longitudinal section of two pipes. A is the groove

FIG: 1.

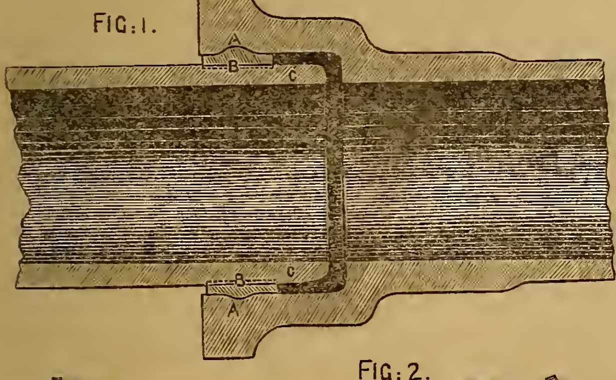
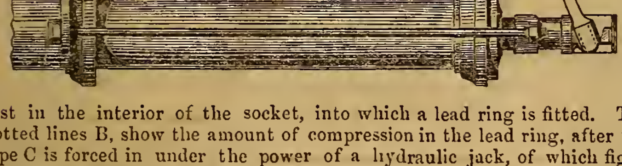


FIG: 2.



cast in the interior of the socket, into which a lead ring is fitted. The dotted lines B, show the amount of compression in the lead ring, after the pipe C is forced in under the power of a hydraulic jack, of which fig. 2 shows the *modus operandi.*

NOTES ON SHIPBUILDING AND MARINE ENGINEERING ON THE CLYDE.

Notwithstanding the shipping trade on the Clyde has shared in the depression which has for some time prevailed throughout the kingdom, it is interesting to notice, as evidencing the facilities possessed by and enterprise existing amongst our shipbuilders and marine engineers here, that during one week alone of the past month three steamers and two sailing vessels, representing an aggregate tonnage of 9,700 tons, were launched from the yards of our leading shipbuilders. These figures will give a fair idea of the greatly increased amount of work in connection with shipbuilding and marine engineering which, when trade is in a more flourishing condition, may be done by the enterprising firms on the Clyde.

We will now give a few particulars relative to the vessels we have just referred to:—

Launch, at Govan, of the Cunard Steamer the "Russia."

The *Russia*, the latest addition to the fleet of British and North American mail steamers, was launched on the afternooon of the 20th ult., from the yard of Messrs J. and G. Thomson, and seldom have we been present at a launch where the time appointed was so punctually kept as in the present case. The christening ceremony was performed by the Hon. Mrs. Campbell, of Blythswood, and the launching was in every respect most successful.

The *Russia* takes precedence, in point of dimensions, over all the screw-propelled ships in the Cunard fleet. Her length, keel and fore-rake, is 336ft.; breadth of beam, 42ft. 5in.; depth of hold to spar deck, 29ft. 2in.; tonnage, B.M., 3,141; capacity in hold, 1,239 tons; capacity in bunkers, 1,100 tons. The hull is chain-riveted throughout, her depth of keel is 12in., and there are eight water-tight bulkheads with water-tight doors, which can be opened and shut from the spar deck. She has three masts, bark-rigged.

Her engines will be of 650 H.P. nominal, direct-acting; diameter of cylinders, 86in.; length of stroke, 3ft. 9in. She will have four tubular boilers, having 1,960 tubes of 3½in. external diameter, and 7ft. long. The total grate surface is 540 square feet; tube surface, 12,300 square feet. The load on safety-valve is calculated at 30lbs. per square inch. The contents of the bunkers is 1,100 tons, and the consumption of coals is calculated at 4 tons per hour. The chimney is 9ft. diameter. Her screw propeller is 19ft. diameter, three-bladed, the pitch being 29ft. 5in. The *Russia* is now alongside Finnieston-quay, adjacent to Messrs. Thomson's engine works, being fitted with her engines, &c.

Launch at Greenock of the "Weser."

Messrs. Caird and Co. launched from their building yard, on the 20th ult., the screw steamer *Weser*, 2,900 tons. The launch was most successful. The *Weser* is a sister ship to the steamers *Bremen, New York, Hansa, Hermann, Deutsehland*, and *Union*, launched by the same builders for the North German Lloyd's Company, and will be employed between Bremen and New York, *viâ* Southampton. Her engines will be of 500 H.P., and be by Messrs. Caird and Co.

Launch at Dumbarton of the "Bangalore."

The magnificent screw steamer the *Bangalore* was launched, on the 21st ult., from the shipbuilding yard of Messrs. Wm. Denny Bros. She is 2,300 tons measurement, the property of the Peninsular and Oriental Company, and will be fitted by Messrs. Denny with engines of 500 H.P. nominal. Messrs. Denny have, we understand, a similar ship in hand for the same Company, and which will be ready for launching early in May.

STEAM BOILER INSPECTION IN THE MIDLAND COUNTIES.

It gives us pleasure to record the highly satisfactory progress made during the past year by the Midland Steam Boiler and Insurance Company, which has for its object not to compete, but to concur with the Manchester Association for the Prevention of Steam Boiler Explosions, and is to the Black Country and the Midland Counties generally what the Manchester Society is to Lancashire, the west of England, and the east of Ireland. The Midland Society combines, with periodical inspections, one special feature, viz., it undertakes the insurance of steam boilers against explosions. However, this is not the case with all steam generators under its care. During the past year there were 890 boilers under inspection, and 1,300 under assurance, making a total of 2,190 boilers under the care of the Company. This number has since been considerably increased.

We have before us the annual report, presented by Mr. E. B. Marten, the chief engineer, at the half-yearly meeting of the directors, at Stourbridge, on February 27th last. The following data, extracted from this excellent paper, will doubtless be found interesting to most of our readers:—

No explosion of any boiler under the care of the Company has happened during the past half-year, nor, indeed, during the whole of the past year, excepting one of a very trivial character. During the five years the Company has been in operation, there has been only one serious claim upon the guarantee fund for an assured boiler, and even that would have been prevented if the warning given of the danger had been attended to. Two other serious casualties have happened to boilers under inspection in the five years, one before opportunity of internal examination had been given, and the other after the danger had been reported. So few explosions among so many boilers in so long a time, and even those few reported as dangerous, clearly show the system of periodical inspection, as provided by the Company, to be of great benefit.

The 2,190 boilers under the care of the Company are used for the following purposes:—917 in collieries, 1,096 in ironworks, and 177 in other works or mills. They are of the following general description—1853 fired externally, and 337 fired internally.

The chief points noticed in the inspection of the boilers during the past year, and mentioned in the reports to owners, may be classed under the two general heads of those relating to the construction, form, setting, material, and workmanship, and others relating to the fittings or working of the boilers. Under the former head attention has been called to the need of strengthening rings for the large internal tubes, frequently referred to in these reports, as the cause of explosion. The extreme weakness of flat ends has several times been detected. Dangerous weakness has often been noticed from large manholes without strengthening rings, and these very frequently further weakened by

corrosion, or by the strain of the clamps too tightly screwed to prevent the leaking of badly made joints. It has been necessary to have some domes strengthened with stays, to compensate for the large holes of three, four, or five feet in diameter, cut out of the shell, although it would have been easier to have left it in with a small hole in the centre for the passage of the steam. Several forms of boiler have been pointed out as needlessly complicated where only a slight advantage has been gained at the sacrifice of durability and facility of cleaning. Many seam-ribs have been discovered in boilers made of extreme length for burning the gases from blast furnaces, and it has been recommended that the evil should be avoided by having two or more shorter boilers set in the same straight flue. Extreme difficulty has been met with in flue examinations from the utter disregard of provision for cleaning out or passing along the flues. Many boilers of small diameter are set at great expense with narrow inaccessible wheel flues, where a plain flash flue would have been better. The external flues of Cornish boilers have been found particularly narrow, and being rounded to match the shell of the boiler, are most difficult and dangerous to traverse, and yet no part of the boiler requires more careful examination to detect corrosion than where the plates touch the brickwork. Several boilers have been noticed with iron of such bad quality as to crack in the body of the plate and through the rivet holes after working only a few months; and rivetting has been detected where the rivet iron has been so bad, and the workmanship so careless, that the heads could be broken off with the blow of a light hammer. Nothing could be greater folly than to attempt to work boilers of such material and workmanship. Perhaps nothing causes greater annoyance to boiler owners than the difficulty of getting repairs properly executed, as boilers are frequently permanently injured by repairing with heavier plates than needed, and straining the old plates up to them; and also by carelessly altering the position of seams, so as to destroy the crossing of joints.

With regard to the points relating to the working of the boilers, it has been necessary to urge the imprudence of using boilers of great age, as in some that have worked for upwards of thirty years, the plates and rivets have been found so much deteriorated as to make it impossible to calculate what pressure they would bear, and render them very uncertain and dangerous. The needlessly heavy fires under many boilers have been noticed, where the fuel was piled up to within a few inches of the boiler, allowing no room for proper combustion, and greatly injuring the plates by overheating a small area over the fire, instead of allowing the flame to circulate as far as possible beyond the bridge. This evil is generally associated with another quite as injurious, and that is regulating the fire by opening the fire door, instead of by using the damper, so that the already overheated plates are exposed to the contracting influences of a stream of cold air.

The most frequent evil pointed out is external corrosion from the leaking of fittings bolted instead of rivetted, or from rain allowed to penetrate beneath the brickwork, and yet corrosion could be most easily avoided by proper vigilance. Safety valves are repeatedly found over-loaded to prevent leaking, when the faces require grinding, and sometimes temporarily repaired with sheet lead inserted between the faces. An over-weighted safety valve is a wilful courting of danger. Many fusible plugs have been noticed as defective, consequently leading to a false feeling of security. Self-feeding apparatus have been found deranged, so that too much confidence should not be placed in them. Many boilers have been found without pressure gauges or with the gauges incorrect or badly placed. It cannot but be remarked, however, that the general condition of the boilers under the Company has improved.

Boiler Explosions during 1866.

The total number of boiler explosions of which records have been obtained, is seventy, causing the death of eighty-five, and the injury of 160 persons, and also great damage to property.

The Exploded Boilers were of the following description:—

Cornish, or others, fired internally	29	34	killed, 85	injured
Plain Cylinders, externally fired	11	12	„ 15	„
Marine	7	16	„ 10	„
Locomotive	5	3	„ 10	„
Agricultural	4	4	„ 13	„
Crane	4	10	„ 3	„
Butterley, Balloon, Breeches Tube, and Elephant	4	2	„ 13	„
Rag or Steam Chambers	2	0	„ 3	„
Upright, for Furnaces	1	3	„ 6	„
Not ascertained	3	1	„ 2	„
Total...............	70	85	160	

The Boilers were used for the following purposes:—

Ironworks	12	13	killed, 51	injured.
Mines and Collieries	12	13	„ 15	„
Marine	7	16	„ 10	„
Railway	5	3	„ 10	„
Cranes	4	10	„ 3	„
Flour Mills	4	5	„ 5	„
Saw Mills..	4	6	„ 12	„
Paper Mills	3	1	„ 3	„
Agricultural...............	2	3	„ 9	„
Leather, Cigar, Brewery, Mungo, Chain, Elastic Chemical Dye or Distillery Works	9	14	„ 35	„
Not ascertained	8	1	„ 7	„
Total...............	70	85	160	

The causes of Explosion were as follows:

Faulty construction, or bad setting or fitting	25	33	killed 55	injured.
Corrosion, Furrowing, bad, or too frequent repair	24	39	„ 81	„
Want of Water	9	7	„ 12	„
Undue Pressure	6	6	„ 6	„
Extraneous, and not ascertained	6	0	„ 6	„
	70	85	160	

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

The following is an abstract of the Chief Engineer's Monthly Report, presented at the ordinary meeting of the Executive Committee of this Association, held at the Offices, 41, Corporation-street, Manchester, on Tuesday, March 5th, 1867, William Fairbairn, Esq., C.E., F.R.S., LL.D., President, in the chair:—

During the last two months 445 engines and 741 boilers have been examined, and four of the latter tested by hydraulic pressure. Of the boiler examinations, 547 have been external, 16 internal, and 178 entire. In the boilers examined 342 defects have been discovered, 11 of those being dangerous.

Of the most serious of these defects fuller particulars may be given.

Fracture.—By far the majority of the defects under this head were met with at the bottom of externally-fired colliery boilers, immediately over the furnace. One boiler, 30ft. long, 6ft. in diameter, made of plates ⅜in. thick, and worked at a pressure of 40lb. per square inch, was found to be rent at the third transverse seam at the bottom of the shell, through the line of rivet holes, for a length of 18in. Had the rent extended a little further, the balance would have been destroyed, and the boiler severed into two pieces and blown from its seat.

Safety-Valves out of Order.—Nearly all of these had been fitted with spring balances, which frequently lead to considerable danger, since many of them are worked to within a pound or so of the ultimate range of the scale, so that an extra turn of the nut by which they are secured, locks them fast, and renders it impossible for the valve to rise. This was found to be the case in two instances during the present month, and our inspector found it impossible to lift the valves so as to make them blow even a breath of steam, reporting that he "did not think 200lbs. would have lifted the valves without lifting the boilers too." The cure for such cases is either to remove these spring balances altogether, or else to disengage them at the bottom and load them with a weight, while, if under any peculiar circumstances it is found desirable to retain them with the lower end attached to a fixed point, then a stop ferrule should be slipped over the screwed shank, so as to prevent the proper pressure being exceeded or the valve jammed fast.

Cases of Deficiency of Water.—One of these, from which the furnace crown was slightly injured through overheating, happened to a small Cornish boiler, about 12ft. 6in. long, and 4ft. in diameter, when it was standing idle at mid-day with the engine at rest, a slow fire burning in the furnace, and steam 15lbs. below the blowing-off point, while there were 5 or 6in. of water in the glass gauge about ten minutes before the furnace crown was discovered to be laid bare, according to the report of the engineer and a bricklayer engaged upon an adjoining boiler. The blow-out apparatus consisted of a mushroom valve, and the attendant states that he found it leaking on examining it immediately after the deficiency of water was discovered. This valve, on subsequent examination, proved to be defective, and could not seat itself properly, while it had frequently given trouble on previous occasions from allowing the water to pass it, which had also been the case with one of similar construction attached to the boiler alongside. Regarding all the circumstances, there seems no reason to doubt that the loss of water was due to the failure of the mushroom valve, which is only another illustration of the untrustworthiness of this description of blow-out apparatus.

Tabular Statement of Explosions, from January 1st, 1867, to February 1st, 1867, inclusive.

Progressive Number.	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
1	Jan. 2	Plain Cylindrical, Egg-ended, Externally-fired	3	3	6
2	Jan. 2	Single-flue. Externally-fired	1	2	3
3	Jan. 26	Plain Cylindrical, Egg-ended, Externally-fired	0	0	0
4	Jan. 30	"Elephant." Externally-fired	2	2	4
5	Feb. 8	Particulars not yet fully ascertained	0	5	5
		Total..................	6	12	18

EXPLOSIONS.—On the present occasion I have five steam boiler explosions to report, which resulted in the death of six, and in injury to twelve persons. Not one of the boilers concerned was under the inspection of this Association. One of them has since been examined by one of the Association's inspectors, and particulars are given below under the head of Explosion No. 2, but of the others, most of which occurred at considerable distances from Manchester, I have not been able to obtain any reliable particulars, the evidence given at the inquests being of a very unsatisfactory character, and to the effect that the explosions were altogether unaccountable, while the juries returned the usual verdict of "Accidental death from the bursting of a steam boiler, the cause of which there was no sufficient evidence to show."

No. 2 Explosion occurred at a forge and rolling mill, at about seven o'clock on the evening of Wednesday, January 2nd, and resulted in the death of one, and in serious injury to two persons.

The boiler, which was externally-fired, and had a flue tube running through it from one end to the other, was set in a somewhat peculiar manner. The fire grate was placed underneath it, but the flames did not pass over a fire bridge at the back of the furnace in the usual way, but escaped from the front, passing directly to the internal flue tube, so that the furnace end of the flue tube was exposed to a more severe action from the flames than it otherwise would have been, which it is important to notice in connection with the manner in which the boiler failed, and which is described below.

The length of the boiler was 32ft., while the diameter in the shell was 6ft. 6in., and the thickness of the plates seven-sixteenths of an inch; the internal flue tube measuring 2ft. 9in. vertically, by 2ft. 7½in. horizontally, and being made of plates fully three-eighths of an inch in thickness. The boiler was fitted with two safety-valves, loaded to a pressure of about 50lbs. per square inch, one of them being adapted for relieving the pressure of steam on the water's falling below the desired level, while there was also a glass water gauge and float. It is important that it should be pointed out that the arrangement for the introduction of the feed was very injudicious; the water, which was cold, being delivered by means of an internal feed-pipe immediately on the ground of the internal flue tube, and at a ring seam of rivets but 6ft. from the front end of the boiler, and thus at the hottest end of the tube.

The boiler gave way in the internal flue tube, which collapsed laterally from one end to the other, the sides flattening and coming together, and at the same time fracturing at some of the ring seams of rivets in consequence of the buckling action of the plates, while the tube was completely severed in two at the seam already described as situated 6ft. from the furnace end of the boiler, and immediately beneath the internal feed pipe.

The explosion was mainly due to the weakness of the internal flue tube, which was badly constructed in the first instance, being an inch and a-half out of the true circle, the vertical axis being greater than the horizontal one, so that it collapsed at the flat sides. Added to this, it was not strengthened as it should have been by encircling hoops, flanged seams, or water pockets, &c.; while, in addition, the introduction of the cold feed water immediately over the crown of the flue tube, and at the hottest end had a most weakening effect, not only by eating the plate almost through, as it had done, but also by inducing irregular contraction, which seems to have been the immediate occasion of the collapse, since it occurred the moment after the feed had been turned on by the poor fireman who was killed by the explosion.

This explosion clearly shows the importance of competent independent inspection. Many boiler makers evidently are quite ignorant of the danger of turning out oval flues in the place of round ones, and at the inquest the maker stated that he approved of the principle on which the exploded boiler had been constructed, and considered the flue, though proved to be an inch and a-half oval yet, to be practically circular. The defects in this boiler would certainly have been detected by competent inspection in time to prevent the explosion.

Although the following explosion occurred a few months since, it may be well now to give the particulars, since it is important to make the record as complete as possible.

No. 42 Explosion, 1866,* by which three men were killed and one injured, occurred on the evening of Monday, August 27th, on board a passenger steam vessel, as she was starting on her voyage, having steamed some three or four miles from port. The vessel was fitted with two boilers of the ordinary marine type, which were placed fore and aft, and measured 12ft. in length and height, and about 16ft. 6in. in width. The boiler that exploded was the forward one, and it gave way at the bottom of the flat end plate at the back, rending horizontally for a length of about 8ft., close to the line of rivets at the bottom angle iron, when the plate hinged outwards, and the steam and hot water rushed into the engine room, and so severely scalded the first and second engineers, as well as the fireman, that they all died on the following day.

It appears that at the back end of the boiler, where the rent occurred, there was a large flat surface unsupported by stays, measuring about 2ft. 6in. high by 16ft. 6in. long, while the load on the safety-valve was 30lbs., and the thickness of the plates three-eighths of an inch. It was not originally intended that this large flat surface should be left unsupported, but the stays had been removed after the boiler had been constructed and set to work. Who is responsible for the removal of these stays is a question on which some discussion has arisen, and on which it is not competent here to enter, but there seems no reason to differ from the conclusion arrived at by the chief surveyor of the Board of Trade with regard to the explosion itself, viz., that it was due to "want of stays," which appears to be corroborated by the fact that on cutting out a similar plate from the other boiler, the surveyor states it was found to be fracturing precisely as the one just described had done, and to be rapidly approaching the point of rupture, so that the aft boiler would soon have exploded in the same way as the forward one.

The evidence at the inquest was anything but satisfactory. Two engineers, under whose superintendence the boiler had been constructed, as well as tested when completed, with water pressure up to 60lbs. per square inch, considered that the explosion was due to a hidden flaw in the plate at the bottom of the back end of the boiler, and that it could not have been prevented by any ordinary foresight. The jury brought in a verdict of "Accidental death."

* See ARTIZAN, vol. for 1866, p. 280.

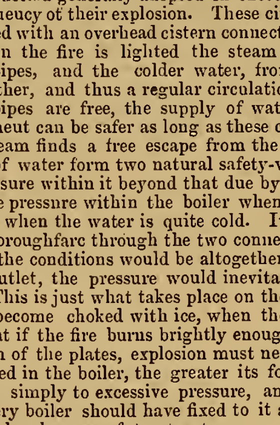
FATAL HOUSEHOLD BOILER EXPLOSIONS.

In addition to the explosions already reported as having occurred to steam boilers employed for manufacturing purposes, six others may be mentioned which happened during the frost in the month of January to boilers in house-hold use, and set in the greater number of cases in kitchens. These explosions were attended with very fatal results. Thus: The first occurred on January 2nd, and by it one person was killed, and another injured. The second on January 3rd, by which one person was killed. The third on January 6th, one person killed. The fourth about January 9th, one person killed, and three injured. The fifth about January 17th, no one injured. The sixth on January 19th, one person killed. Total: Six explosions, five persons killed, and four injured. Considering the number of these explosions, as well as their fatality, little apology is required for referring to the subject, especially since those most exposed to injury are domestic servants, totally ignorant of the danger incurred, and so many of them appear to suffer from these explosions on the recurrence of every frost, and will, it is feared, continue to do so as long as the present construction of these boilers continues unaltered.

It is reported that all the exploded boilers just referred to were on the circulating system, and although a personal examination has not been made, yet it is thought that the construction generally adopted in these boilers affords an easy explanation of the frequency of their explosion. These circulating boilers are for the most part constructed with an overhead cistern connected to them by means of two pipes, so that when the fire is lighted the steam and heated water rise through one of these pipes, and the colder water, from its superior gravity, descends through the other, and thus a regular circulation is set up, which continues as long as the pipes are free, the supply of water kept up, and the fire burning. No arrangement can be safer as long as these conditions are complied with. The surplus steam finds a free escape from the overhead cistern, while the two open columns of water form two natural safety-valves to the boiler, and entirely forbid any pressure within it beyond that due by gravity to their height, so that there is no more pressure within the boiler when the fires are burning, however brightly, than when the water is quite cold. It will readily be seen, however, that if the thoroughfare through the two connecting pipes were at any time to become closed, the conditions would be altogether altered, and the steam having no longer any outlet, the pressure would inevitably accumulate within the pipes and boiler. This is just what takes place on the occurrence of a frost. The circulating pipes become choked with ice, when the pressure is bottled up within the boiler, so that if the fire burns brightly enough to raise the pressure to the ultimate strength of the plates, explosion must necessarily ensue, and the more hot water contained in the boiler, the greater its force. These explosions, therefore are attributed simply to excessive pressure, and to prevent this, it is recommended that every boiler should have fixed to it a metallic safety-valve, which, being unaffected by changes of temperature, would come to the rescue when frost sealed the other outlets.

It may be added that should the water supply at any time run short, whether from frost or from being suddenly cut off by the water company, it might be well to withdraw the fire before the boiler can be run dry and overheated, not that it is thought that such serious consequences would result from the sudden re-introduction of the water, as it is very generally supposed, but the boiler, if heated, might be seriously strained and injured, though it is questioned if it would be destroyed. It may easily be ascertained whether the boiler is supplied with water or not, by opening a test tap on the circulating pipes.

The annexed wood engraving shows a vertical section at one-third size of the safety-valve, recommended on account of its simplicity, which is a miniature



adaptation of a valve in very satisfactory use on many of the large steam boilers under the inspection of the Association. It is of external pendulous dead weight construction, the seat of the valve being spherical, and without either guide fangs or spindle, so that there is nothing to interfere with its free action or impede the thoroughfare. The central hollow pedestal on which the valve seats, is of brass, as well as the external cylindrical shell which

drops over it, and contains the valve itself, while the weight is simply a ring of lead. The area of the opening at the valve seat is a quarter of a square inch, so that every pound weight on the valve gives a pressure of 4lb. on the boiler, while 45ft. is the total head of water which the valve shown is calculated to balance. It is important that these safety-valves should not have a greater load on them thau that due to the head of water, as many of the boilers are not strong enough to bear it, aud therefore the safety-valves will require different loads for different positions. The proportions of the shell and dead weight have therefore been arranged for easy calculation, the shell beiug adapted for a constant head of 10ft. of water, and the lead weight for a head of 35ft.. which is equal to 10ft. for each inch measured upou it vertically, since it is 3½in. high. Thus, with the lead weight as shown, the valve is adapted for a column of 45ft.: with a weight of 3in. high, for a column of 40ft.; with one of 2in., for a column of 30ft.; and of 1in. for a column of 20ft.; while, should the valve be required to balance a column of greater height than 45ft., the lead weight could easily be increased either in height or diameter.*

The position of the valve, and the mode of fixing it to the boiler, must depend upon convenience in each instance. It is shown in the drawing with a wrought-iron flange, attached to the valve with a screwed nipple, aud which can be secured to the boiler by bolts tapped iuto the plate. This may be convenient in some cases where the valve can be planted directly on the top of the boiler: while in others, it may be better to fix it with a short pipe, which can be curved or not as required. Iu one already fixed, the brickwork above the boiler was recessed, and the valve placed in the niche, being covered in out of harm's way by a small cast-iron door, fitting into a cast-iron frame driven into the brick-work. This valve was fixed in consequence of the frost of January, 1865, and has not been found to give any trouble from leakage or otherwise.

With regard to the cost of these valves, it appears, from an estimate obtained from a brassfounder, that they can be made for about 10s. each, while, if applied to boilers already in use, the connection would probably cost 5s. for material, and another 5s. for labour, making about £1 in all; but, if the boilers were adapted for them when first made, and the valves fixed at the same time, they could be turned out complete for about 10s., so that it will be seen the expense is inconsiderable.

There may doubtless be other safety-valves of equal merit with the above, but on account of its known efficiency uuder other circumstances, it is trusted that the preceding description will prove of service, but whether this particular construction be adopted or not, it is recommended that no new household boiler should be turned out without an efficient safety-valve of some sort, while boilers iu use without them, having supply pipes at all liable to be affected by frost, should have a valve added as shortly as possible.

Siuce the above was written, the views therein expressed have been corroborated by practical experiment, which showed that the danger of injecting water into red-hot boilers has beeu greatly exaggerated. These experiments were couducted on Saturday, the 2nd inst., and I am indebted for the means of carrying them out to the kindness of Messrs. Isaac Storey and Son, of Manchester, who provided me, at their own expense, with three boilers, at the same time affording the assistance of their workmen, with all necessary appliauces and the convenience of their premises, on which the experiments were conducted. As the question involved is one of very general importance, relating not only to the safety of household boilers, hut also to the explanations so frequently given of the cause of explosions occurring to large steam power boilers, it is thought that the details of the experiments would prove of interest.

Three differeut boilers were experimented ou, all of them beiug of the ordinary household circulating class.

The first of these boilers was made of copper, weighed 62lbs., and measured 14¼ins, in height, 11¾ins., in width, by 13¾ius. in depth at the bottom, and about 8ins. at the top, which gave an internal capacity of 1 cubic foot as nearly as may be. This was placed, when perfectly empty, on the top of a briskly burning fire, as well as surrounded with it, and allowed to remain so for a considerable time, till the bottom became thoroughly red-hot, and lumps of lead freely melted, though but loosely laid on the top, which was the coldest part of the boiler, being out of the reach of the flames. When the boiler was in this conditiou, water was suddenly let into it through a pipe about ½in. in bore, connected to the Water Company's main. No explosion, however, took place, the boiler was not stirred from its seat, neither did it tremble or evince the slightest signs of internal commotion; all that took place was a rush of steam through au outlet ⅞in. in diameter, left on the top of the boiler. It was necessary to have this opening, or the water would not have found its way into the boiler at all, as was proved by actual experiment with it closed, when the first puff of steam generated forbade the entry of more water, and drove back through the feed pipe. The opening, however, would not have had the slightest effect in preveuting the bursting of the boiler, if the views entertained with regard to the explosive effect of dashing water on red-hot plates were correct, the action of which is supposed to be as irresistible and instantaueous as that of gunpowder.

The result of this experiment was so unmistakable that it appeared of itself to be conclusive, but still it was thought more satisfactory to repeat it with another boiler, of slightly differeut dimensions, by way of corroboration.

The second boiler, which like the first, was of copper, weighed 44lbs., and measured 11¾in. in height, 11½in. iu width, by 10½in. in depth at the bottom, and 8½in. at the top, having a flue tube running through it 6in. in diameter, so that it had an internal capacity of about ⅝ths of a cubic foot. This boiler was surrounded, just as the previous one had been, by a brisk fire, which operated not only on the bottom and sides, but also on the internal flue tube, and it was allowed to remain perfectly empty as in the previous experiment, until lead, loosely laid on the top, freely melted, and nearly half of the boiler became red-hot, when water was suddenly turned into it through a pipe of 1iu. bore connected to the hoiler at one end and to a tank, affordiug a head of from 6 to 8ft. in height at the other. This plan of feeding was adopted in preference to that in the first experiment, thinking that the increased size of the pipe would give a more sudden injection of water, and thus prove more favourable to an instantaneous generation of steam. The result, however, was precisely the same as in the previous experiment; no explosion whatever occurred, the boiler remained perfectly still, and the only effect of the injection of the water was the escape of a jet of steam through an orifice 1in. in diameter, which had beeu left open on the top of the boiler.

This experiment, therefore, completely corroborated the previous oue; but inasmuch as both of the boilers referred to above were made of copper, whereas many in use are made of cast-iron, it was thought well to repeat the experimeut with a cast-iron boiler, which it was expected would prove more favourable to explosion, not only on account of the brittleness of its material, but also from its greater weight of metal, which would afford increased capacity for heat, and thus for rapidly geuerating steam.

The third boiler, which, as just stated, was of cast-iron, weighed 85lbs., and measured 15¼in. in length, 10in. in height, by 11½in. in depth at the hottom and 8¼iu. at the top, having an internal capacity of less than a cubic foot, while the bottom was arched, which increased the heating surface. This boiler, like the previous ones, was heated till the greater part of it became red hot, and lead melted on the top; indeed, it was in such a glowiug heat, that it appeared, on looking into it through a small orfiice, as if the bottom had heeu hurnt out, and the eye was looking directly into the fire itself. Water was then laid on, as in the previous experiments, by means of a pipe 1in. in diameter, connecting the boiler to a tauk giving a head of from 6ft. to 8ft., hut there was no orifice left open on the top of the boiler as before, a safety-valve, loaded to a pressure of about 35lbs. on the square inch, being substitnted. On openiug the tap in the connecting pipe, and letting the water on, no result whatever was apparent. The safety-valve did not blow, and the boiler neither cracked nor trembled, but the feed pipe was found to get hot up to the tap, some 15ft. from the boiler, as if the steam was beating back and forbidding further entry of the water. After allowing the boiler to rest in this position for some time, with the fire briskly burniug around it, the safety-valve was lifted, when a very moderate escape of steam took place, and continued as long as the valve was kept open, but ceased as soon as it was allowed to fall. Finding that no resnlt could be produced with the safety-valve attached to the boiler, it was removed, and an orifice of 1¼in. iu diameter left open instead. Ou turning the water on again a jet of steam escaped from the orifice as before, and shortly after the boiler cracked on one side from the top to the hottom with a sharp report. This was due simply to the contraction of the metal, and the rupture did not spread, neither did the hoiler stir from its seat. The water was kept on till the boiler was nearly filled, but no result followed differeut to those already described.

To render the experiments as conclusive as possible, it was thought well to repeat the last one for corroboration, and therefore the boiler was removed from the fire, emptied, and replaced, the connections being completed just as before with the exception that the safety-valve was omitted, and the orifice on the top reduced to a diameter of three-eights of an inch. On turning ou the water again, the only result was a jet of steam as before, which issued from the orifice on the top of the boiler in a constant stream as long as the feed tap was kept open, and intermittently when it was opened and closed alternately.

It should he added that the capacity of these boilers was such that a pressure of about 150lb on the square iuch would have been generated within them by the evaporation of a quarter of a pint of water in the two larger oues, and an eighth of a pint iu the smaller one, and though they were heated all over, as already described, yet it is clear that that pressure could never have been attained, or even approached, as the light, flat-sided copper boilers did not bulge in the least, while the rush of steam from the outlet never appeared more than could be taken off by an ordinary safety-valve.

It will be seen from the results of the foregoiug experiments, that all the attempts to explode the boilers totally failed. Every endeavour, however, was made to succeed, and everything that glowing red hot plates and cold water could do, under the circumstances described, was done, while it is thought that the test adopted was much more severe than auy which could occur in actual work, either to a household hoiler on the occurrence of frost, or to one employed for engine power on the furnaces being over-heated, and the feed suddenly re-admitted to the red hot plates. Iu the case of the household boiler, the fire rarely operates further than upon the bottom and one or two of the sides, whereas the experimental ones were completely surrounded by fire, so that the amount of heated surface was greater in the experiment than it could he in practice; while the injection of the water through the supply pipe of an inch bore, simply by openiug a tap, was, it is thought, at least as sudden as it possibly could be by the thawing of a column of ice; added to which it was shown by experiment that the water would not flow into the boiler without a free outlet as well as a free inlet, so that unless both of the circulating pipes were open at the same time, but little water would get into the boiler. In the case of the steam hoiler for engiue purposes, its capacity would be very much larger in comparison with the amount of heated surface exposed on the furnace crowns being laid bare than in the experimental ones, so that the force of the steam would be proportionally reduced, aud so much so in practice as to be completely swallowed up.

The experiments were witnessed by others as well as myself, the desire of all being to make them as satisfactory and conclusive as possible, and though we failed in exploding the boilers, I trust something may have been done towards exploding the theory they were instituted to test, a theory which has done so much to perpetuate fatal steam boiler explosions by arresting full investigation,

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* It may prove of convenience to the brass founder to state that for the above proportions, with a diameter of nine-sixteenths of an inch at the bore of the valve seating, the weight of the external brass shell should be 1lb. 1oz., as nearly as may be, and that of the lead weight 4¼lb. or 1lb. 1oz. for each inch of its height.

and throwing dust in the eyes of coroners and jurors, while inquiring into the cause of these sad catastrophes.

These experiments may, it is thought, be accepted as conclusive, that the idea of explosions arising from the instantaneous generation of a large amount of steam through the injection of water on to hot plates is a fallacy; and that the bursting of circulating boilers during frost is due simply to accumulated steam pressure within them from the choking of the outlet pipes with ice, while that pressure may be relieved and explosion prevented by a good safety-valve, as previously recommended.

INSTITUTION OF CIVIL ENGINEERS.

ON THE WORKING OF STEEP GRADIENTS AND SHARP CURVES ON RAILWAYS.

By Captain H. W. Tyler, Assoc. Inst. C.E.

It was remarked that the comparative terms, steep and sharp, had acquired at the present day a signification very different from what they conveyed to engineers a few years since. The locomotive engine had been gradually trained and adapted to gradients of 1 in 100, 1 in 50, 1 in 25, and 1 in 12, combined with curves of from 30 chains down to 15, 10, 5, and even 2 chains radius; and during all this progress, the result of so much labour and ingenuity, the system of bite, or adhesion, by plain surfaces, had steadily triumphed as a means of converting steam-power into tractive force. The co-efficient of adhesion was always in the first instance under-estimated; and the central-rail system, first patented by Mr. Vignoles (M. Inst. C.E.) and Mr. Ericsson, on the 7th of September, 1830, was intended to provide extra adhesion on what were now considered moderate gradients, in place, apparently, of the well-known rack-rail of Blenkinsop.

In conveying heavy loads up gradients much less steep than several which had been worked, for a greater or less number of years, with engines of ordinary construction, a want of extra adhesion had been seriously felt, and various expedients had been resorted to for obtaining it. M. Flachat proposed, in constructing railways over the Alps, to utilise the adhesion not only of all the wheels of the engine and tender, but also, by the use of additional cylinders, &c., to them, of all the vehicles composing a train. Mr. Sturrock had added cylinders and the necessary apparatus to the tenders, and employed them for some time as assistant engines on certain parts of the Great Northern Railway. M. Thouvenot, on the continent, and Mr. Fairlie, in this country, combined two tank engines in one, placed, as it were, back to back, and united as to their boilers and fire-boxes.

In the ordinary system of obtaining adhesion by bearing-wheels only, whether of an engine and tender, or of a double engine, or of two engines coupled together, the weight of the motive power required to be increased for a given amount of adhesion, in proportion to the load or to the steepness of the gradient. The limit of the gradient up which such an engine could take a load might roughly be defined by the co-efficient allowed for adhesion. Supposing this to be one-tenth, then 1 in 10 was (omitting friction) the gradient on which an engine might move itself, but on which no load could be taken. As on the railway over Mont Cenis, the adhesion might vary from one-sixth to one-twelfth, and as gradients were required of 1 in 12, it was necessary to adopt some other method than that of trusting to adhesion by bearing wheels; and having a high summit to surmount, it was of great importance, with reference to cost of working, to save weight in the engine as well as in the trains. By adopting the principle of horizontal wheels and a central rail, Mr. Fell (Assoc. Inst. C.E.) found the means of doubling the adhesion, at the same time that by the use of steel, the engine was made lighter than it could otherwise have been. This principle was first tested, experimentally, on the Cromford and High Peak Railway; and subsequently on a line, $1\frac{1}{4}$ mile in length, laid on the road over the Mont Cenis, with an average gradient of 1 in 13, containing curves with radii varying from 4 to 2 chains. The gauge was 3 feet $7\frac{3}{8}$ inches (1·10 metre), and the middle rail was laid on its side horizontally, at an elevation (to its centre) of $7\frac{1}{2}$in. above the bearing rails. The engine constructed specially for the Mont Cenis was partly of steel. Its weight was now 14 tons, and its mean weight, when fully loaded with fuel and water, 17 tons, of which 2 tons 13 cwt. was for the machinery connected with the horizontal wheels. There were only two cylinders, each 15in. in diameter, with a length of stroke of 16in., which worked both the four coupled horizontal, and the four coupled vertical, wheels, all 27in. diameter. The wheel base of the vertical wheels was 6ft. 10in., and that of the horizontal wheels was 2ft. 4in. The pressure upon the horizontal wheels could be regulated by the engine driver at pleasure from the foot-plate. This pressure was applied through an iron shaft, connected by means of right and left-handed screws with a beam on each side of the middle rail, and these beams acted upon volute springs, which pressed the horizontal wheels against that rail. The pressure employed during the experiments was from $2\frac{1}{2}$ to 3 tons on each horizontal wheel, or 10 tons altogether; but the pressure actually provided for, and which might, when necessary, be employed, was 6 tons upon each, or 24 tons upon the horizontal wheels. The vertical wheels were worked indirectly by piston rods from the front, and the horizontal wheels directly by piston rods from the back of the cylinders. The results of the different experiments on the Mont Cenis Experimental Railway were given in several tables, which showed that considerably more could be accomplished than had been proposed in the programme handed to the French and Italian Governments. During the official trials, in the month of July, 1865, before the French, Italian, and Russian Government Commissioners and others, with a load of 24 tons, exclusive of the engine, the distance run in fifteen trips was 51·040 kilomètres ($31\frac{3}{4}$ miles, nearly) at an average speed in ascending of 10·704 kilomètres (6.65 miles) per hour; while with a load of 16 tons, the distance ran in eight trips was 29·12 kilomètres (18.09 miles), at a speed of 15·6 kilomètres (10 miles nearly) per hour. During these twenty-three trips, the pressure of the steam increased 500lbs., or 21lbs. on the average for each run. In the month of November, 1865, when some other trials were made, a maximum speed was attained of 12 kilomètres (7.46 miles) per hour, with a load of 24 tons, and 18 kilomètres per hour, with a load of 16 tons. As evidence of the power of the breaks, it was stated that when the ordinary and the central rail breaks were combined, with a gross load of 41 tons, descending a gradient of 1 in 12, at a speed of about 6 kilomètres per hour, the train was stopped within 20 mètres, while under similar circumstances a gross load of 33 tons having a speed of about 12 kilomètres per hour, was stopped in 20 mètres. It was remarked during the later trials, that the engine and train gained speed on the sharpest curves. This effect, so contrary to general practice, was produced, partly by the action of the horizontal guide wheels, which kept the engine and the wagons in their proper positions with respect to the rails, and partly to the fact that the gradients on the curves had been slightly eased, while the gradients on the straighter portions had been made proportionally steeper, with the intention of as nearly as possible balancing the resistances.

Another system for working steep inclines—that of Signor Agudio—had found support in Italy. In it two stationary engines were employed, one at the summit and the other at the bottom of an inclined plane, which acted upon the same double endless rope, kept stretched by a tension wagon hanging upon it at each extremity. This rope ran between the rails, and over two sets of wheels worked by the stationary engines, from which it received its movement by friction. It did not act directly upon the train, but was connected with an engine, called the "locomoteur funiculaire," supported on a bogie frame at each end, and carrying a system of drums and wheels, by the action of which the required motive power was obtained indirectly by the moving rope. Experiments tried with this system on the Dusino incline between Turin and Genoa in August, 1863, appeared to have given great satisfaction to the Commissioners of the Royal Institute of Lombardy. But the author was inclined to think, that neither this system, nor any other yet developed, could compete with the central rail system for general traffic on gradients up to 1 in 10 or 1 in 12.

For mountain passes the author believed the middle rail system possessed great advantages. Besides being of service in the ascent, it afforded the means of employing pressure breaks, acting with any amount of force, to any number of vehicles, and thus rendered the descent safe, and supplied a remedy against bad consequences from a fracture of the couplings. It also prevented the engines, or any vehicles of the train that were supplied with guide-wheels, from leaving the line, from a defect in the permanent way or rolling stock. A country which required very steep gradients demanded also, in most cases, very sharp curves; and the central rail contributed to safety as much in respect to the latter as to the former. On the Mont Cenis Experimental Railway, the bearing-wheels of the engine left the rails on two occasions, and on both they were brought back to the rails by the guiding power of the central rail. As, however, in the course of about three months, the line was expected to be opened from Susa to Lanslebourg or Modane, and in from five to six months from the present time throughout its whole length of 48 miles between St. Michel de Maurienne and Susa, there would then be an opportunity of becoming better acquainted with this plan.

At the monthly ballot the following candidates were ballotted for and duly elected:—as members—Mr. Amias Charles Andros, Resident Engineer of the New Dock Works, Leith; Mr. Henry David Furness, Locomotive Superintendent of the Riga-Dunaburg and Dunaburg-Witepsk Railways; Mr. Robert Edward Johnston, Engineer of the Shrewsbury and Hereford, Shrewsbury and Wellington, and Shrewsbury and Welshpool Railways; Mr. William Jarvis McAlpine, New York; and Mr. Allan Wilson, Westminster; as Associates, Mr. Horace Bell, Executive Engineer, Public Works Department, Bengal; Mr. Francis Bramah Gilbertson, South Eastern Railway of Portugal; Mr. Spencer Herapath, Kensington; Mr. George Houghton, Resident Engineer on the Berlin Görlitz Railway; Mr. Charles Harlowe Lowe, Assistant Surveyor of St. Marylebone; Major William Palliser, Army and Navy Club; and Mr Edward Pritchard, Surveyor to the Local Board, Bedford, Lancashire.

INSTITUTION OF ENGINEERS IN SCOTLAND.

On Friday night, the 22nd ult., a conversazione and assembly in connection with the Institution of Engineers and Shipbuilders in Scotland took place in the Queen's Rooms, West End, Glasgow. A numerous and brilliant company assembled upon the occasion. Amongst the gentlemen present were Professor Rainy, Professor Allen Thomson, Bailie William Taylor, Bailie Gilkison, Bailie Collie, Bailie Murray, Sheriff Galbraith, Mr. J. G. Laurie, President of the Institution, &c. Letters, explanatory of absence, were received from Professor Sir William Thomson, Professor C. Piazzi Smyth, and the Lord Provost. In two of the ante-rooms a number of photographs, various engineering models, and a miscellaneous assortment of other objects of interest, were exhibited. Particular attention was directed to several views of the great pyramid of Jeezeh, and the measuring bars, &c., employed by Professor Smyth during his sojourn in Egypt; as also to specimens of the Atlantic cable. During the evening, Mr. Thomas Inglis, C.E., Glasgow, gave a description of the great pyramid, which, at the instance and on behalf of Mr. Aiton, formerly of Glasgow, now of Wales, he surveyed during the summer of 1865. He remarked that in the course of his survey he levelled over the structure, and found its height to be 456ft. The top of the pyramid measured about 33ft. square, and the area of the foundation

covered was upwards of 13 acres. In the large hall, decorated for the occasion by Mr. Alexander Cochrane, Renfield-street, dancing was commenced shortly after ten o'clock, and continued for some hours to the music of Mr. R. J. Adams, band.

ROYAL GEOGRAPHICAL SOCIETY.

The seventh meeting of the present session of this Society was held at Burlington House, on Monday evening, the 25th February, Sir R. I. Murchison, Bart., President, in the chair.

The first paper read was "On Explorations of the Purus and Aquiry in the Amazons Basin," by W. Chandless, Esq., M.A. Mr. Chandless was incited to the exploration of this stream by the importance attached to it by the people of Southern Peru and Brazil, as well as by European geographers, who supposed it would form an uninterrupted water-communication between the rich provinces of Southern Peru and the Atlantic, via the Amazons. All previous attempts to ascend it had been frustrated, not by difficulties in its navigation, but by lack of perseverance and enterprise. In 1864 Mr. Chandless engaged a small native canoe and a crew of Indians, and ascended the river nearly to its sources, a distance of 1,866 miles, finding a good depth of water, and no obstacles to navigation for the greater part of the way. It is peopled only by a few tribes of Indians, each speaking a distinct language. The banks are formed of alluvial soil, and are covered throughout with dense forest, rich in india-rubber trees and other vegetable products of commercial value. The stream, however, was found not to lead to the settled districts of Southern Peru, as had been supposed; the Indians met with near the sources had never had communication with white men or civilised tribes, and were ignorant of the use of iron. A specimen of their stone axes was exhibited at the meeting, and it was supposed that this tribe was the same as the one spoken of by the Count de Castelnau, who heard of them when descending the Ucayali, in 1846. In 1865 Mr. Chandless undertook a second journey, with the view of ascending the Aquiry, the most important southern affluent of the Purus, which he thought might possibly be the navigable river known as the Madre di Dios, flowing from the Andes, east of Cusco. He ascended this stream also nearest to its source, finding it to terminate, like the main river, in the midst of trackless forests. He then attempted to cross by land, and hewed a way through the forest for nine days, but was obliged finally to abandon the attempt. The Aquiry in the dry season had but little depth of water, and in its upper course was encumbered with trees that had fallen from the banks; but in the flood-season it was a navigable river. Both the Purus and the Aquiry were carefully mapped during both journeys, and Mr. Chandless was so determined to lose no opportunity of fixing his positions by astronomical observation, that, on one occasion, when surprised by a rising of the water flooding the sand-banks, the only places on which he could find a tract of open ground for his purpose, set off down stream with all the speed the paddlers could master, in order to beat the stream and reach a place where the banks were yet uncovered.

At the conclusion of the paper the President commended in high terms the courage and ability of Mr. Chandless, who, as a private English gentleman, had accomplished what a powerful government had failed in, and reminded the meeting that the Society had decreed him one of the royal medals for his first exploration of the Purus.

The second paper was "On the Rivers of Caravaya in Southern Peru," by Don Antonio Raimondy, honorary corresponding member, who had in 1864 explored several of the streams, formerly supposed to be the head-waters of the Purus, but which are now decided to flow into the Beni and Madeira. The author traced the rivers San Gavan and Ayapata from their sources in the snowy range of Caravaya to their junction with the Inambari. Each stream descends by a narrow, wooded ravine, separated from the others; and the scenery, in descending from the icy plains to the rich tropical valleys, was described as most magnificent. A map of the various rivers, detailed meteorological observations, and notes on the distribution of the plants of the region, accompanied the paper.

ROYAL INSTITUTION OF GREAT BRITAIN.

ON MR. GRAHAM'S RECENT DISCOVERIES ON THE DIFFUSION OF GASES.

By William Odling, M.B., F.R.S.

I.

When atmospheric air is separated from a vacuous or partially vacuous space by a septum, partition, or bag of india-rubber, some air passes through the septum into the original vacuous space.

This space may be conveniently maintained vacuous, and any air passing into it be simultaneously withdrawn and delivered for examination, by means of Sprengel's exhauster.

Whereas atmospheric air consists of about 21 per cent. of oxygen and 79 per cent. of nitrogen, the air transmitted through india-rubber into a vacuous space is found to contain about 40 per cent. of oxygen and 60 per cent. of nitrogen, and to have the property of re-inflaming a glowing splinter.

A transmission, therefore, takes place through the rubber septum of both constituents of the atmosphere, but there is a greater proportionate transmission of its oxygen than of its nitrogen.

Single or unmixed gases, similarly separated from a vacuous space by a septum of india-rubber, penetrate the rubber, and enter the vacuous space with the following relative velocities :—

Nitrogen	1	Oxygen	2·55
Marsh-gas	2·15	Hydrogen	5·50
Carbonic acid	13.58		

From these velocities the observed passage of mixed ogygen and nitrogen gases through india-rubber is deducible by calculation; and conversely, the separate velocities of oxygen and nitrogen are deducible from the transmission-results obtained with atmospheric air :—

Oxygen	21	×	2·55	=	53·55	40·4
Nitrogen	79	×	1	=	79·0	59·6
					132·55	100·0

The constituent gases of atmospheric air not only pass through an india-rubber septum into a vacuous space, but also into a space containing some other gas, such as hydrogen or carbonic acid, and at the relative velocities with which they enter a vacuous space; but the conditions of the experiment then become more complicated.

In the case of an india-rubber balloon filled with carbonic acid, for instance not only are atmospheric oxygen and nitrogen gases continually entering the balloon, but carbonic acid gas is continually and very rapidly escaping from it.

Throughout the vacuum experiment the conditions remain constant, the hyperoxygenised air being withdrawn as fast as transmitted; but in the balloon experiment the oxygen is gradually accumulating within the balloon, whereby the conditions are constantly varying.

Eventually, by the rapid escape of carbonic acid, the proportion or pressure of oxygen in the internal mixture comes to exceed that in the external air; whereupon a reverse transmission through the balloon, of the excess of oxygen into the external air, at once begins.

II.

When ordinary coal-gas is separated from the vacuous space by a septum, partition, or tube of platinum, some gas passes through the platinum septum into the originally vacuous space as soon as, but not until, the metal is raised to the temperature of ignition.

Whereas coal-gas is a variable mixture of marsh-gas and hydrogen with several other gases and vapours, containing on the average about 45 per cent. of marsh-gas and 40 per cent. of hydrogen, the gas transmitted through ignited platinum is found to consist exclusively of hydrogen.

A transmission therefore of only one, and that not the most abundant of the many constituents of coal-gas, takes place into the originally vacuous space through a septum of ignited platinum.

So that while the nitrogen of the air is transmitted through a septum of india-rubber in a much smaller ratio than its oxygen, the other constituents of coal-gas are transmitted through a septum of ignited platinum in an infinitely smaller ratio than is its hydrogen.

Experimenting with single or unmixed gases, the quantity of hydrogen transmitted through a septum of ignited platinum into a vacuous space amounting to over 100 cubic centimetres in half an hour; whereas, under the same conditions, the quantity transmitted of oxygen, nitrogen, marsh-gas, carbonic acid, and some other gases, did not amount to ·01 cubic centimetre in half an hour.

Further, the transmission of hydrogen through a septum of ignited platinum, as of various gases through a septum of india-rubber, takes place into a volume of some other gas as well as into a vacuum, but with a similar complication of results.

What is the nature of these transmissions of gas through india-rubber and ignited platinum respectively? Are the phenomena in the two cases similar or dissimilar to each other; and with what class of actions are they one or both associated?

III.

By a sufficient degree of pressure gases may be forced through the minute channels of a porous septum; or, in other words, may pass through such a septum by transpiration.

But transpiration takes place only through obvious channels or pores, from which platinum and india-rubber and platinum are entirely free.

Again, transpiration through a porous system takes place only in the direction of the preponderating total pressure; but the transmission of gas through india-rubber and ignited platinum, from one gaseous space into another, can take place in the opposite direction to that of the total pressure, and in both directions at the same time, by a sort of interchange of gases through the septum.

Moreover, the composition of a mixed gas, such as atmospheric air or coal-gas, is not altered by mere transpiration; whereas the composition of these mixed gases is greatly altered by their transmissions through india-rubber and ignited platinum respectively.

Lastly, every gas and every mixture of gases has its own special velocity of transpiration, irrelative to any other property of the gas, and irreducible to any general law. These rates are altogether different from the observed rates of transmission of the same gases through india-rubber and ignited platinum, thus :—

Oxygen	1·00	Carbonic acid	·73
Nitrogen	·87	Marsh-gas	·55
Hydrogen	·44		

From these differences in the character of the phenomena, as well as from another important difference hereafter to be mentioned, it is clear that the transmission of various gases through india-rubber, and of hydrogen through platinum, is not due to transpiration.

IV.

As the channels of a porous septum become more and more minute, their resistance to the bodily transmission of gas becomes greater and greater, and

the quantity of gas forced through them less and less, until at length the septum becomes absolutely impermeable to transpiration under the particular pressure.

But such a septum, of which the individual capillary channels are so small as to offer a greater resistance, or friction, to the passage of gas through them than the available pressure can overcome, may nevertheless present a considerable aggregate of interspace, through which the proper diffusive movement of gases, due to their innate molecular mobility, may take place freely.

When any volume of gas is allowed access to a vacuous space, or to an additional gaseous space, it gradually diffuses itself throughout the space afforded it, at a rate inversely proportionate for each gas to the square root of its specific gravity.

In so far as the aggregate area of interspace available for diffusion is greatly diminished, by the introduction of a porous non-transpiring septum between the diffusing gas and the additional space afforded it, so is the amount of diffusion within a given time proportionably diminished; but in no other aspect does the septum appear to take any part in the action; it neither promotes nor retards the diffusion, but simply allows it to take place in proportion to the aggregate area of the interspace which it affords.

The experimental determination by means of Bunsen's diffusionometer of the relative diffusion-velocities of different gases through a thin plate of compressed graphite—a septum without obvious pores and quite impermeable to transpiration—has given numbers which are almost identical with the reciprocals of the square roots of the specific gravities of the several gases:—

Hydrogen	3·80	Nitrogen	1·01
Marsh-gas	1·34	Oxygen	·95
Carbonic acid	·81		

Interdiffusion of different gases takes place in proportion to their respective diffusion-velocities. Thus with air and hydrogen separated from each other by a graphite-septum, for every 1 volume of air which passes into the hydrogen-space, 3·8 volumes of hydrogen pass into the air-space.

Mixed gases also diffuse away from one another according to their respective diffusion-velocities. As a result of even the small superior diffusiveness of nitrogen over that of oxygen, the proportion of oxygen in atmospheric air has been increased from 21 to 24·5 per cent. by the diffusion of nitrogen away from it, during its conveyance through several lengths of porous tobacco-pipe enclosed in a vacuous space.

The acts of gas diffusion through porous septa and of gas transmission through india-rubber and ignited platinum resemble each other in several points. They both take place through septa free from obvious pores; they both take place as well in the direction as against the direction of the preponderating pressure, and also in opposite directions at the same time by a sort of interchange; and they both effect an alteration in the composition of any mixed gas subjected to their operations.

But they differ altogether from one another in the relative velocities with which the gas movements in each case are effected—the transmissions of gas through india rubber and ignited platinum being at special rates, while the diffusions of gas through porous septa are inversely as the square roots of the specific gravities of the particular gases.

Thus the specific gravity of nitrogen being somewhat less than that of oxygen, its rate of diffusion is accordingly somewhat higher, in the proportion of 101 to 95. Hence, if the passage of air through the rubber septum were due to diffusion, the transmitted air should be rather richer in nitrogen and poorer in oxygen than the original air; whereas the transmitted air is actually found to be very much richer in oxygen and poorer in nitrogen than the original air.

Again, hydrogen having a far lower specific gravity than marsh-gas, its diffusion rate is very much higher, in the ratio of 380 to 134. Hence, taking the proportion of marsh gas to hydrogen in coal gas, as 1 to 1, and it is usually rather greater, if the passage of coal gas through ignited platinum were due to diffusion, for every 380 volumes of hydrogen transmitted there should be 134 volumes of marsh gas: but in reality no marsh gas whatever is transmitted; so that neither with the rubber septum nor with the platinum septum are the results due to diffusion.

It is rare to have phenomena of diffusion undisturbed by phenomena of transpiration, or phenomena of transpiration undisturbed by phenomena of diffusion; but since the alteration in the composition of a mixed gas by its passage through a transpiring diffusing septum is affected solely by diffusion, the results obtained with the rubber and platinum septa are not due to joint transpiration diffusion.

V.

A septum may be quite free from pores of any kind or degree of minuteness, and so far be absolutely impermeable to the passage of gas through it in the form of gas, but may nevertheless permit a considerable transmission of certain gases by their prior solution or *liquefaction* in the substance of the septum.

The merest film of water, as of a soap-bubble for instance, is quite impermeable to gas as gas; but allows the ready transmission of a soluble gas, such as ammonia, through it, by reason of a prior solution or liquefaction of the ammonia in the film of water.

The film of water may be replaced by a moist membrane of any degree of thinness or thickness, with a similar result.

In this case the phenomenon consists in a solution of the gas in the moist material of the septum—in a diffusion of the liquefied gas as a liquid through the thickness of the septum—in an evaporation of the liquefied gas from the remote surface of the septum—and lastly, in a diffusion of the evaporated gas into the adjoining space.

Of the many circumstances affecting the final result, the influence of the solubility of the gas in the liquid of the septum would so far predominate over all other influences as to allow of their being left out of consideration. Whence it may be affirmed that the transmission of any gas through a film of liquid, or a moist septum, will be found proportionate to the solubility of the gas in the liquid.

But gases are absorbable not only by liquids, but also by certain solids, and especially by charcoal.

The gases absorbed by charcoal are probably liquefied in the charcoal; at any rate, the more absorbable of them occupy a bulk considerably less than if reduced to the liquid state by pressure.

All charcoal is more or less porous; but its absorption of gases is not proportionate to, or a mere physical effect of, its porosity; since other similarly porous substances do not manifest the same absorptive power; and since the absorbability by charcoal of any gas is as special a property of that gas as is its solubility in water, or alcohol.

The transmission of an absorbable gas through a septum of compact charcoal, such as the cocoa-nut charcoal used by Mr. Hunter of Belfast, which absorbs about $\frac{8}{10}$ of its volume of mercury, and 111 times its volume of ammonia, would take place in two ways.

A portion of the gas would pass through the fine pores of the charcoal as gas, by diffusion, at a rate inversely proportionate to the square root of it specific gravity; while another portion would become liquefied in the charcoal by capillary condensation, pass through the charcoal as a liquid, and evaporate from the other side, just as would a gas liquefied by solution in a moist membrane; and it is conceivable that, in some compact forms of charcoal, the transmission of gas by gaseous diffusion might be inappreciable as compared with its transmission by liquefaction and evaporation.

VI.

Whereas the mere passage of gas through a transpiring or diffusing septum takes place in thorough independence of the nature of the material of the septum, in these last considered actions the transmission takes place by virtue of a sort of chemical affinity between the gas and the material of the septum—the selective absorption of the gas by the septum being a necessary antecedent of its transmission; whence it may be said that the gas is transmitted because it is first absorbed.

Is, then, the transmission of oxygen, &c., through india-rubber, and of hydrogen through ignited platinum, effected by a process, at all allied to that of gas liquefaction by solution or capillary condensation?

That septa of india-rubber and platinum differ from merely diffusive and transpiring septa, in effecting or allowing a selective transmission of certain gases through them, is evident; but do they first exert a selective or, in other words, a chemical absorption of these particular gases?

Experiment answers that they do; oxygen proving to be more than twice as absorbable by india-rubber as by water, and hydrogen proving to be fully three times as absorbable by wrought platinum as by charcoal.

The statements of fact and interpretation contained in this abstract are based upon the investigations of Mr. Graham, spread over a long period of years; and especially upon the investigations described in his more recent memoirs "On the Molecular Mobility of Gases" (Phil. Trans., 1863), and "On the Absorption and Dialytic Separations of Gases by Colloid Septa" (Phil. Trans., 1866).

ON NEW ENGLAND.

By Moncure D. Conway, Esq.

The men and women who left England in the dawn of the seventeenth century and landed on Plymouth Rock represented the filtered strength of the English people. It was because they feared they would in Holland, where they first sought refuge from persecution, lose their English name and speech, that they resolved to seek the shores of America, where their wild home was rightly named New England. They were 102 in number—28 women—who landed at Plymouth in 1620, and there was not a feeble heart nor a blockhead among them. Their wildly-cradled infant colony was born on Christmas Day, but they toiled through every hour of it, though the bitter cold could not induce them to work on their cabins the previous day, it being Sunday. The first years of the colony were lowly enough, forming hand to hand struggle with nature for subsistence; but from this was evolved national character.

The section in which the pilgrims settled has a distinctive physical character After describing at considerable length the features of the country and its great beauties, the speaker referred to the Indians, of whom the pilgrims found about 50,000 in New England when they landed. The first impression of the Indian is attractive, on account of his fine physical appearance; but the near view reveals his repulsive characteristics. The power of his senses has not been exaggerated. He is, however, a brainless savage, by no means the right figure for a central position in America. The Puritans began by being scrupulously just to the Indians; but the Indian could not be made to understand an English bargain. He thought that a thing reverted to him when what he had received for it was exhausted. This led to the Indian wars. But the Indians were hardly so heavy a trial to the Puritans as the power from which they had fled in England, but which found them out so soon as they had any success. The king gave their lands to his favourites, and they had to share whatever they could wring from their hard soil; and even this was not so hard on them as the effort made to crush their religion; the noblemen thinking it a disgrace that their American estates should be worked by a party of vulgar "separatists." Neither they nor their religion was crushed, however. At the end of twenty years there had been drawn thither 20,000 people, and they were building good ships, and had a good trade. They were distributed into the settlements which were the germs of the six New England States by natural forces. The barrenness and the fine water-power of Massachusetts—the mother state—decided that it should be a manufacturing state; these parties went out to the grazing uplands of New Hampshire and Vermont, and to the meadows of Connecticut, to get

wool and grain for those mills of Massachusetts. Rhode Island was planted by Roger Williams, an eloquent Oxonian, who fled from the persecutions of Laud, and was too much of a Radical for the Puritans to tolerate. The State of Maine was settled through the free trade that was opened by the French of *Nouvelle France* in the north with the Boston colony; the first of the long column of benefactions on which rests what is called the traditional friendship between America and France. The hostility of the Indians made every inland migration a costly one.

In 1643 the various settlements formed the first American Confederation. It was partly a mutually defensive union, but mainly a religious one. The body which represented it was a Council in which each settlement, however large or small, had two members; and in this respect it was the original senate. There was no President, but only a Moderator chosen by the Council. They adopted the Mosaic code as their constitution; but it is not true, as is generally supposed, that their laws were unusually rigorous. Whilst England and Scotland had as yet 30 offences punishable with death, New England had only 10. It was in small affairs, and in the interference with private conduct, that Puritan rigour was felt chiefly, although they were guilty of cruelties in the instances of the Quakers and other heritics. However, those "heretics" were never punished for *heresy* with anything beyond banishment from the colony; the scourges, and the four memorable executions of Quakers, were punishments for the defiance of magistrates involved in repeated returns, when death had been named as the penalty for the final return. At this time New England was a religious aristocracy. The preachers were also the magistrates. Only Church members could vote. This had hardened into a despotic regime. But a silent power—the free school—had even at that early period been set in motion, which, when the persecution of the witches came on, was shown to have undermined the clerical power. The people released the condemned witches, and swept out of pulpits and from benches the judges and preachers concerned in their prosecution. Amid this revulsion at the close of the 17th century, the authority of the clergy in New England closed, and the era of religious liberty began.

The period stretching from the year in which the last witch was executed—1693—to the Revolution of Independence was one of great intellectual and moral growth. Under the masterly neglect of the Duke of Newcastle, to whom the administration of that region was so long committed, the New World matured its powers, and the colonies silently became Republics. The Revolution was but the publication of a fact. It was a victory in which both sides won, and decided that the New World is not to be a duplicate of the Old.

Independence came upon New England like the breath of a tropic. Its industry had always been great. The cultivable land is only about the size of England, but its products for 1866 may be represented by £250,000,000. The single state of Massachusetts is a flint not larger than three English counties, yet out of it came last year £100,000,000, which is thrice as much as in 1845. The taxable property of that state, apart from all public institutions, is over a thousand millions of dollars.

One-third of the American people are of New England descent. Another third is of other English settlements. It is undeniable that the races of the old world have been modified in the new, and the English more than others. "The full and florid habit," says Dr. Palfrey, "the moist skin, the curly hair, and sanguine temperament so general in Great Britain, have in America been replaced by a comparatively slender form, dry skin, straight hair, and bilious or nervous temperament." With more flesh than the American, the Englishman has not quite so large a skeleton. Agassiz has admitted this fact, though it is unfriendly to his theories. Haller gave the average height of the European man as 5 feet 5 inches; the measurements of New England soldiers in the late war show them to be 5 feet 8 inches. The New Englander reaches his maximum of size later in life than the European. There is, doubtless, a slight infusion of the Indian characteristics in the American. These traits are possibly physiognomical. In religion, in education, the skeleton or type is large, though not yet completely filled out. With less scholarship than Europe, America has a better school-system. New England may be called a large university. Her system of education has been filtered through 230 years, and is so complete that it is impossible to find a healthy native of the country uneducated. In coming in contact with the people fresh from work and reality, the colleges have lost much of their monasticism, and science has become paramount in them. This enthusiasm for scientific studies has influenced literature. Nearly all the men of letters in America are of New England. Forty years ago American thought began to cease to be the refrain of English thought, and to assume those distinctive characters which are best represented in transcendentalism. The transcendental movement has revolutionised the beliefs and politics and institutions of America more than anything else. It was a kind of spiritual Positivism. When Emerson—whom the future will call the father of his country rather than Washington, whose birthday America is now (Feb. 22) celebrating—first held up his torch, the old imported order still stood in mountains of ice around him; but his torch was multiplied, conflagrations came of it, and the hills melted. Something like a deluge has followed; but those who shall see the solid land again, shall find that this was only the needed irrigation, before it should put forth faiths fresh as prairie grass, and states stabler than mountains.

CHEMICAL SOCIETY.

ON THE ABSORPTION OF VAPOURS BY CHARCOAL.

By John Hunter, M.A., F.C.S., Chemical Assistant, Queen's College, Belfast.

The paper which I had the honour of laying before the Chemical Society, early last session, contained the results of a series of experiments on the absorption of vapours by cocoa-nut charcoal. Since that time I have determined a large number of absorptions, which are given in the present paper. In consequence of the difficulty of using a liquid having a much higher boiling point than oil of turpentine in the apparatus previously described, it was necessary to adopt an altogether different method, which would enable me to observe the absorption of vapours heated in a bath of paraffin. For this purpose a copper vessel was employed into which the absorption tube was introduced by means of a tightly-fitting cork. The neck into which the cork was fixed consisted of a cone-shaped double chamber, which allowed the melted paraffin to flow in between the two surfaces, so as to protect the cork from being destroyed by the heat of the gas. The sides of the vessel extended below the bottom, in order to prevent the flame flaring up on the outer surface. The heat was applied to the bath by means of a hollow ring supplied with gas-jets, which fitted on the stand. The lower extremity of the absorption-tube dipped into a carefully graduated glass vessel filled with mercury.

In performing an experiment, the graduated absorption tube was first introduced into the paraffin bath, and securely fastened by means of the cork; it was then filled with mercury and inverted in the glass vessel. The level of the mercury in this vessel was observed, the capsule containing the liquid whose vapour absorption was to be examined introduced into the absorption tube, and heat applied to the copper vessel. When the desired temperature was indicated by the thermometer suspended in the paraffin bath, the mercurial level was again read, and the charcoal introduced as in the former experiments. As the absorption proceeded, the mercury was depressed in the glass vessel, and when this remained constant, the level was again observed. The value of the divisions of the absorption tube being known, the difference in height of the mercury in the tube and bath could be determined, and the absorption deduced by a simple calculation.

In the following tables containing the vapour absorptions at various temperatures, it will be noticed that from 195° C. to 200° C., one volume of cocoa-nut charcoal absorbs 110·7 volumes of vapour of aniline, 102·0 of carbolic acid, and 101·1 of hydride of benzoyl.

I have examined the absorption of several vapours by means of the apparatus described in a former paper and found that aldehyde, acetic ether and acetone are absorbed respectively, 138·7, 116·0, and 104·6 at 100° C. by one volume of cocoa-nut charcoal.

In the tables, V represents the number of volumes of the vapour absorbed by one volume of of cocoa-nut charcoal at the temperature and pressure at which the experiment is performed. T and T′ are the initial and final temperatures; P and P the pressures deduced by subtracting the difference in level from the height of the barometer.

	V	T°	T′°	P	P
		ANILINE.			
	113·6	196·5	201·8	604·3	587·0
	108·0	200·0	202·5	602·3	600·8
	110·5	194·0	193·0	603·2	588·2
Mean...	110·7	196·8	199·1	603·3	592·0
		CARBOLIC ACID.			
	106·2	197·3	197·5	596·8	592·3
	100·0	195·0	191·0	604·3	585·4
	100·0	193·5	193·5	590·1	577·4
Mean...	102·0	195.3	194·0	597·1	585·0
		HYDRIDE OF BENZOYL,			
	101·8	195·7	198·0	551·8	542·9
	100·0	192·5	191·0	577·8	568·5
	101·6	202·0	200·5	582·8	573·3
Mean...	101·1	196.7	196·5	570·8	561·0
		BUTYRIC ACID.			
	83·0	195·3	194·5	591·1	515·4
	83·3	197·0	199·2	592·8	577·6
	88·8	199·2	199·3	575·1	556 9
	82·1	197·7	197·0	585·6	570·1
Mean...	84·3	197·3	197·5	588·1	570·0
		BUTYRIC ETHER.			
	72·0	201·0	199·0	596·3	591·4
	77·7	192·0	191·5	599·6	590·8
	75·0	198·7	197·0	605·9	600·0
Mean...	74.9	197·2	195·8	600·6	594·1
		OIL OF TERPENTINE.			
	50·1	197·7	192·3	584·0	576·3
	45·5	195·4	195·0	597·5	593·8
	48·4	192·7	192·7	582·5	573·5
Mean...	48·0	195·3	193·0	588·3	581·2
		VALERIANIC ACID.			
	40·9	198·0	198·0	575·5	569·5
	41·3	198·0	197·0	591.0	581·1
	41·4	197·5	197·0	577·8	573·1
Mean...	41·2	197·8	197·3	681·5	574·5
		ALDEHYDE.			
	61·6	155·0	157·2	693·0	695·0
	67·7	153·5	155·5	673·0	675·1
	67·9	154·7	156·5	689·3	699·3
	69·4	154·0	151·0	679·3	677·8
Mean...	66·6	154·3	155·0	683·9	686·8

	V	$T_\circ$	$T_\circ$	P	P
	136·9	100·0	100·0	688·0	673·5
	137·5	100·0	100·0	689·5	682·5
	141·7	100·0	100·0	684·0	686·5
Mean...	138·7	100·0	100·0	687·1	680·8
		ACETIC ETHER.			
	72·7	154·0	155·0	697·5	688·5
	72·4	155·5	154·5	691·0	672·5
	69·4	153·0	151·2	686·5	675·0
Mean...	71·5	154·1	153·6	691·7	678·7
	118·0	100·0	100·0	695·2	677·2
	112·8	100·0	100·0	675·5	663·2
	114·5	100·0	100·0	660·5	662·5
	119·0	100·0	100·0	674·3	658·0
Mean...	116·0	100·0	100·0	676·4	665·2
		ACETONE.			
	63·5	156·5	156·0	694·7	674·7
	59·9	155·5	157·0	688·8	674·3
	73·7	157·0	158·0	692·0	666·5
	75·2	155·0	156·3	688·8	669·3
Mean...	68·0	156·0	156·8	691·1	671·4
	100·8	100·0	100·0	665·5	649·4
	102·6	100·0	100·0	655·7	648·7
	108·0	100·0	100·0	644·5	643·5
	101·3	100·0	100·0	650·5	627·0
	105·0	100·0	100·0	644·8	631·3
	109·0	100·0	100·0	661·7	650·2
	105·3	100·0	100·0	660·0	644·0
Mean...	104·5	100·0	100·0	654·6	641·9
		NITROUS ETHER.			
	60·1	100·0	100·0	666·2	661·2
	64·7	100·0	100·0	661·2	671·7
	68·7	100·0	100·0	655·0	665·0
	62·4	100·0	100·0	656·5	656·5
	62·2	100·0	100·0	665·5	658·5
Mean...	63·5	100·0	100·0	660·8	660·6
		HYDROCHILORIC ETHER.			
	63·0	100·0	100·0	673·1	678·6
	56·8	100·0	100·0	668·6	655·6
	60·5	100·0	100·0	674·3	671·8
	56·9	100·0	100·0	671·5	662·5
	64·7	100·0	100·0	675·3	673·8
Mean...	60·4	100·0	100·0	672·5	668·4
		FORMIC ACID.			
	30·4	158·0	160·0	707·8	697·8
	31·5	155·3	157·5	695·0	688·5
	30·7	156·0	157·5	687·5	681·0
Mean...	30·7	156·4	158·3	696·7	689·1
		AMYLENE.			
	16·5	155·0	156·0	662·5	656·0
	22·6	155.0	154·7	640·3	643·3
	16·2	156·0	156·0	655·0	658·0
Mean...	18·4	155·3	155·5	652·6	652·4
		PERCHLORIDE OF CARBON.			
	3.2	154·0	154·0	706·0	702·5
	4·1	154·5	154·5	692·2	685·7
	3·8	155·0	155·0	696·8	695·3
Mean...	3·7	154·5	154·5	698·3	694·5
	8·2	100·0	100·0	681·2	687·7
	7·8	100·0	100·0	678·7	679·2
	7·9	100·0	100·0	687·5	690·5
Mean...	7·9	100·0	100·0	682·4	635·8

ON A CHLORSULPHIDE OF CARBON.

By Walter Noel Hartley.

In the preparation of a large quantity of dichloride of carbon or tetrachlorethylene, a solution of hydropotassic sulphide was used for reducing the terchloride of carbon, according to the following equation :—

$$C_2Cl_6 + 2KHS = C_2Cl_4 + 2KCl + H_2S + S.$$

The mode of operation was as follows :—To a mixture of the di- and terchlorides, which contained as an impurity the protochloride of carbon, was gradually added the reducing agent prepared by dissolving potash in absolute alcohol and passing sulphuretted hydrogen through to saturation; after warming slightly, the re-action ceased, and the reduced chloride of carbon was precipitated by water from its solution in the alcohol, separated and distilled. There was a residue in the retort after distillation, which had a brown colour and a remarkable smell, suggestive of a sulphur compound. For examination, a portion was heated in a test-tube, and the result was a sublimate of sulphur and fine needle-shaped crystals. On digestion in alcohol, the substance proved to be soluble, and left on evaporation a deposit of brownish crystals. To purify this substance, it was boiled in a flask with much alcohol and animal charcoal, an inverted condenser being attached to prevent the waste of alcohol; the liquid after about four hours was filtered hot and allowed to cool in a porcelain basin; the crystals were separated; and the alcohol was used again to extract what yet remained in the flask; a fresh crop of crystals formed, and the alcohol, with a little added to it, was used again and again, until the solid residue was exhausted. The substance, not yet quite pure, was again treated with alcohol and charcoal, and the filtrate was allowed to evaporate spontaneously. The resulting crystals, sligbly yellow in colour, were dried under the air-pump and submitted to analysis. The specimen being only small, as little as possible was used.

0·109 grms. burnt with chromate of lead, gave 0·0519 grms. of carbonic acid, corresponding to 0·0141 grms. of carbon, or 12·93 per cent.

0·115 grms. were burnt in a small combustion-tube with pure quicklime, and oxygen was passed through the tube; it was then, while hot, dipped cautiously into water as in an ordinary chlorine determination, and treated with nitric acid. The solution yielded with nitrate of baryta 0·424 grms. of sulphate, corresponding to 0·058 grms. of sulphur, or 50·43 per cent.

On treating with nitrate of silver, the filtrate yielded 0·17 grms. of chloride of silver, corresponding to 0·042 grms. of chlorine, or 36·52 per cent.

	Found by analysis.	Calculated for the formula $C_2Cl_2S_3$.
C	12·93 per cent.	12·56
Cl	36·52 „	37·17
S	50·43 „	50·26
	99·88 „	99·99

The formula deducible from these data is, then, $C_2Cl_2S_3$, the name applicable under these circumstances being chlorsulphoform, a body of the composition $C_2H_2S_3$, being already known and called sulphoform, it being chloroform in which sulphur replaces chlorine.

Chlorsulphoform crystallises from solutions and by sublimation in fine needles, possessing a disagreeable and peculiar smell, soluble in alcohol and ether with difficulty; easily soluble in chloroform, the bisulphide, and the liquid chlorides of carbon, and in oil of turpentine. Its melting point is not below 250° C., and it begins to sublime before it melts. When it is treated with moderately strong nitric acid in sealed tubes, for three or four hours at 120° to 130° C., white crystalline scales are formed, of which I had not enough for analysis, but from their containing sulphur, which fact I proved, and the nitric acid containing sulphuric acid, they may be regarded as a substance with, perhaps, this formula, $C_2Cl_2SO_2$. The formation of the chlorsulphoform can be in no way explained, except by supposing that the sulphur, produced in the reducing process, just as it gains its state of freedom, combines with the protochloride of carbon (C_2Cl_2). Facts support this idea; for if there be no C_2Cl_2 in the mixture to be reduced, none of the new compound is formed, and unless much sulphur be separated in the reaction, we find the C_2Cl_2 unacted upon; a solution of the hydropotassic sulphide alone has no action on it. I do not know that any other substance has been obtained by the action of nascent sulphur; if not, this may be the first instance of the formation of a compound being attributed to such an agent. The subject of this paper is part of an unfinished research upon which I was working last year in the laboratory of Professor Kolbe.

AMERICAN RAILWAY TRAVELLING.

The *Chicago Western Railroad Gazette* contains the following notice of the accommodation provided for travellers in the trains plying on the Canada Great Western Railway, the laying of a third rail on which has just completed an unbroken route of uniform gauge between Chicago, New York, and Boston. "The inauguration train introduced us some luxurious novelties of travel. Among them was an hotel car, with a little kitchen. At each seat tables can at once be put up, and on the passenger touching a bell-cord, a servant promptly responds with a bill of fare, from which the traveller selects such edibles as best suit him, and is presently enjoying all the comforts of an admirably cooked and served meal, while going at the rate of forty miles an hour. Two palace sleeping cars, the May Flower and the City of Detroit, also went through without change. Each contains six sofas and twenty-six seats. The finest of Wilton carpeting covers the floor, the woodwork is all black walnut, carved and inlaid with gilt, windows and ceiling are ornamented in the Moorish style; mirrors hang opposite each side, tables for eating, writing, and playing are ready

at hand; curtains made to order and imported, cover the windows, and the room in the daytime resembles an elegant parlour. But when night comes on, a few moments change the scene, and luxurious beds for sixty-four people appear, with costly hair mattresses and pillows, and clean, absolutely clean, sheets, and coverings. In the morning each passenger is handed his separate towel, hot and cold water are ready in convenient washrooms at each end, and he finds himself refreshed and comfortable, hundreds of miles from where he retired to rest in this flying hotel. An even and gentle heat is diffused from one of Westlake's heaters beneath the floor, and pure ventilation is effected by openings below, through which the air is brought in pipes from the roof, and diffused through the car, escaping at the ceiling when found to be impure. All the metal work inside is plated with silver, and a bright light is diffused at night from great lamps pendant from the ceiling. The cars run on two trucks of eight wheels each, and the motion is so smooth that a person can easily write while going at full speed. These cars are among the wonders of this rapid age."

ROYAL SOCIETY.

ON A NEW METHOD OF CALCULATING THE STATICAL STABILITY OF A SHIP.

By C. W. Merrifield, F.R.S., Principal of the Royal School of Naval Architecture.

The time required for the calculations of the stability of ships has practically restricted the ordinary draughtsman to the use of the metacentre. This implies that the locus of the centres of buoyancy cuts the transverse midship plane in a curve which may be treated as a circle; and this is only true, in general, for very small limits of inclination. In some particular cases it has been felt desirable to supplement this by computing the moment of stability at some definite angle of inclination, by means of the "ins and outs," or immersed and emersed wedges. But this has only been applied to one selected inclination, generally of 10° or 14°; and owing partly to this, and partly to the very scant time left available to the skilled draughtsman or calculator, this has never been a part of the ordinary work of the computation of a ship's quantities. For this reason it becomes of great consequence to find some method of getting at the stability, with an amount of extra work, which should not exceed that of the ordinary sheet known as the "sheer-draught calculation."*

A method has occurred to me by which, as I think, this object may be attained. Upon conferring with some of my students,† who have suggested and removed certain difficulties of detail, we think we see our way, by an easy calculation, to place the whole account of a ship's statical stability in the hands of any person who understands simple equilibrium, either in an algebraical or geometrical form, as he may prefer.

It will take some time, with my present occupations, to prepare detailed examples. But as the method is complete in respect of principle, I have thought it best to bring it at once before the society.

The fundamental assumption is, that the locus of the centres of buoyancy can be sufficiently represented by a conic. The stability is then measured by the perpendicular, from the centre of actual weight, on the normal due to the inclination. The chief step, therefore, is to find the conic, of which, I may remark, we already know the vertex, and the tangent and curvature at the vertex; for these are given by the ordinary calculation of the centre of buoyancy and the metacentre. Now I observe that the conic is completely determined if we can find the length of another radius of curvature corresponding to a known inclination. This is obtained by finding the moment of inertia about one of its principal axes (longitudinal) of the plane of flotation at the inclination. This, divided by the unaltered displacement, gives the radius of curvature required.

But the chief practical difficulty lay in finding the means of drawing an inclined water-line across the body plan, so as to give an unaltered displacement. This I have at length succeeded in overcoming, as follows:

The sheer-draft calculation gives us *inter alia* the areas of the level sections, belonging to the upright position, as rectangles. Now, if we make one side of each of these equal to the length of the ship, their breadths form a series of ordinates for a curve of mean section; that is to say, the transverse section of a cylindrical body, of which the displacement at any level immersion will be the same as that of the ship. We then make out a scale of displacement for this section at various immersions, for a selected inclination, taking care to measure the immersions on the middle line of the original body plan. By this means the finding of any water-line at the selected inclination is reduced to a problem of plane geometry and it is obvious that the place of the water-line so found will be a very close approximation to that of the required plane of flotation in the ship.

The calculations are as follows:—

1. Take out the horizontal areas from the sheer-draught calculation, and divide each by the ship's length. Set them off right and left from a vertical line at their present vertical interval, and draw a curve through their ends.

2. Any practised draughtsman will have little difficulty in drawing, at sight, an inclined line of flotation which shall give an unaltered immersed area on this mean section. He can verify it by measuring the immersed and emersed triangles obtained by his first guess, and make the correction due to the difference, if they do not agree.

3. In strictness, the more accurate course would be this,—through each of the vertical stations draw right lines at the selected angle. Thence, by Simpson's rule, form a scale of areas, ending at the highest inclined water-line. Use the vertical interval of the upright displacement, and neglect the cosine of the inclination. Then divide the upright displacement by the ship's length and by the cosine of the inclination, and find to what immersion this displacement corresponds in the scale of inclined areas. But this is needless, unless the calculations have to be made for different draughts of water.

4. Use this immersion to draw the inclined plane of flotation in the body plan.

5. Calculate the area, common moment, and moment of inertia of this plane, about the longitudinal axis formed by its intersection with the original plane of flotation, upright.

6. Transfer this moment of inertia to the longitudinal axis passing through the centre of gravity of the inclined plane of flotation.

7. Divide the moment so found by the displacement. This will give the radius of curvature of the locus of the centres of buoyancy, corresponding to the selected inclination.

The conic is now implicitly determined. It remains to show what use is to be made of these data.

Let $\rho\theta$ be the radius of curvature, corresponding to the angle θ, made between the normal and axis of a conic; then

$$\rho_\theta = \frac{a(1-e^2)}{(1-e^2\sin^2\theta)^{\frac{3}{2}}},\ \rho_0 = a(1-e^2).$$

From these we obtain

$$e^2 = \frac{\rho_\theta^{\frac{2}{3}} - \rho_0^{\frac{2}{3}}}{\rho_\theta^{\frac{2}{3}}\sin^2\theta}, \qquad (a$$

$$1 - e^2 = \frac{\rho_0^{\frac{2}{3}} - \rho_\theta^{\frac{2}{3}}\cos^2\theta}{\rho_\theta^{\frac{2}{3}}\sin^2\theta}, \qquad (b)$$

$$a = \frac{\rho_0\,\rho_\theta^{\frac{2}{3}}\sin^2\theta}{\rho_0^{\frac{2}{3}} - \rho_\theta^{\frac{2}{3}}\cos^2\theta}, \qquad (c)$$

$$ae^2 = \frac{\rho_0(\rho_\theta^{\frac{2}{3}} - \rho_0^{\frac{2}{3}})}{\rho_0^{\frac{2}{3}} - \rho_\theta\cos^2\theta}; \qquad (d)$$

and these afford the means of calculating all the elements of the conic.

Now, let us take any other inclination ϕ: we may calculate ρ_ϕ from the foregoing value of e^2 by means of the formula

$$\rho_\phi = \frac{\rho_0}{(1 - e^2\sin^2\phi)^{\frac{3}{2}}} \qquad (e)$$

Now, if λ be the distance of the centre of gravity of the ship below the metacentre of the upright position, and p the perpendicular from the centre of gravity on the normal of the conic in the inclined position, we shall have

$$\frac{p}{\sin\phi} = \lambda + \frac{\rho_0^{\frac{2}{3}}(\rho_\phi^{\frac{2}{3}} - \rho_0^{\frac{2}{3}})}{\rho_0^{\frac{1}{3}} + \rho_\phi^{\frac{1}{3}}\cos\phi}; \qquad (f$$

and $p \times D$ is the moment of stability, D being the displacement.

Strictly, it is only necessary to use the formulæ (*a*), (*e*), (*f*) in actual work. Formula (*f*) shows clearly how an alteration in the position of the weights affects the stability. If λ be altered, the altered value of p is obtained (geometrically) by a very obvious construction.

In Mr. Scott Russell's treatise on "Naval Architecture," p. 604, it is shown how the stability may be obtained by geometrical construction when the conic is known.

It is worth while to remark that the condition that the conic should be hyperbola, or an ellipse, is

$$\rho_0 < = \text{ or } > \rho_\theta \,.\, \cos^3\theta$$

* See "Shipbuilding, Theoretical and Practical," by Watts, Rankine, Barnes and Napier, p. 46, for sheer-draught calculation commonly used in this country.

† Messrs. Deadman, Edgar, John and White.

and whether the ellipse is referred to its major axis, becomes a circle, or is referred to its minor axis, depends upon whether

$$\rho_0 <, =, \text{or} > \rho;$$

θ having any value whatever within the limits of continuity.

It is to be observed that this method only applies on the supposition that there is no abrupt discontinuity. The immersion of the gunwale, for instance, would vitiate it. But in ordinary ships, experience leads to the conclusion that a conic would be a very accurate representation of the locus of centres of buoyancy within all reasonable limits.

I have not waited to try the method throughout upon a specific example. But every step is separately well known, most of the steps familiarly so, within my own experience. My *estimate* of the extra amount of work is, that it would be rather less than would be involved in making an independent calculation of the ordinary sheer-draught work. I shall have an immediate opportunity of verifying this in my school; but I wished to announce the method publicly before beginning to teach it.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

FALLING BODIES.

To the Editor of The Artizan.

Sir,—According to the table of "Results of experiments made to determine the dynamical effect of bodies falling freely," by C. H. Haswell, of New York, one pound falling one foot shows a result of 35·5lbs.; and as the effect increases directly as the weight, if a man fell from a height of one foot (say his weight is ten stone), he would strike the ground with a force of 4,970lbs., or upwards of two tons. This seems enigmatical. Perhaps Mr. Haswell would favour us with a description of the instrument by which he obtained his results.

Yours truly, C. S.

REVIEWS AND NOTICES OF NEW BOOKS.

Engineering Facts and Figures. Glasgow and London: Fullarton and Co. 1866.

This work, which takes a pretty complete view of the principal events which have transpired in engineering during the past year, recommends itself chiefly by its careful and methodic compilation. The facts which it records, though exclusively obtained from the professional periodicals of the day, easily accessible to the slenderest purse, are none the less acceptable on that account to those who may prefer to get their information from this volume, where it is presented to them in a more accessible shape, though, in our opinion, for a book of facts, still much encumbered with words. From the title of the work, we should have expected to find a great number of data useful to the engineering student in daily wants of office routine; and though the present volume is an improvement upon previous issues, we believe that future volumes may be still further improved by proper attention to this suggestion. The references to articles and illustrations in some of the technical periodicals are well chosen and exceedingly useful; other sources, however, might be usefully drawn from.

NOTICES TO CORRESPONDENTS.

Inquirer (Stoke Newington).—The information sought may be obtained from either of the published works of D. K. Clark or Zerah Colburn. The latter work is being republished by Collins and Co., of Glasgow, in monthly parts.

B. N.—You will find this radius insufficient in practice. It should be no less than the total height of the fall. The angle of the buckets must be a great deal sharper. The breadth will do very well.

Query.—The centigrade thermometer is, at the present day, in general use on the Continent, for all engineering and scientific purposes. The province of the Fahrenheit thermometer is confined to Great Britain and the United States, whilst the Reaumur thermometer is used in every-day life in Germany and Russia. The general introduction of the centigrade thermometer is one of the objects of the International Decimal Association; its adoption will involve far less difficulties than that of the metrical standards of weights and measures.

X. Y. Z.—Your composition, on being cast, is not likely to contract more than about 1-130th, but it might be less. It is advisable to use the utmost care in mixing the component parts.

PRICES CURRENT OF THE LONDON METAL MARKET.

	March 2.			March 9.			March 16.			March 23.		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, selected, per ton	84	0	0	85	0	0	82	0	0	82	0	0
Tough cake, do.	81	0	0	83	0	0	80	0	0	80	0	0
Copper wire, per lb.	0	1	0½	0	1	0½	0	1	0½	0	1	0½
„ tubes, do.	0	1	0	0	1	0	0	1	0	0	1	0
Sheathing, per ton	85	0	0	87	0	0	84	0	0	84	0	0
Bottoms, do.	91	0	0	96	0	0	90	0	0	90	0	0
IRON.												
Bars, Welsh, in London, per ton	6	7	6	6	7	6	6	10	0	6	10	0
Nail rods, do.	7	0	0	7	0	0	7	0	0	7	0	0
„ Stafford in London, do.	7	15	0	7	15	0	7	15	0	7	15	0
Bars, do.	7	15	0	7	15	0	7	15	0	7	15	0
Hoops, do.	8	15	0	8	15	0	8	15	0	8	15	0
Sheets, single, do.	9	10	0	9	10	0	9	10	0	9	10	0
Pig, No. 1, in Wales, do.	4	5	0	4	5	0	4	5	0	4	5	0
„ in Clyde, do.	2	14	6	2	14	9	2	14	0	2	14	0
LEAD.												
English pig, ord. soft, per ton	19	10	0	20	0	0	20	0	0	20	0	0
„ sheet, do.	20	5	0	20	10	0	20	5	0	20	5	0
„ red lead, do.	21	5	0	21	5	0	21	5	0	21	5	0
„ white, do.	27	0	0	27	0	0	27	0	0	27	0	0
Spanish, do.	19	0	0	19	0	0	19	0	0	19	0	0
BRASS.												
Sheets, per lb.	0	0	10	0	0	10	0	0	10	0	0	10
Wire, do.	0	0	9	0	0	9	0	0	8½	0	0	8½
Tubes, do.	0	0	11	0	0	11	0	0	11	0	0	11
FOREIGN STEEL.												
Swedish, in kegs (rolled)	14	0	0	14	0	0	14	0	0	14	0	0
„ (hammered)	16	0	0	16	0	0	16	0	0	16	0	0
English, Spring	19	0	0	19	0	0	19	0	0	19	0	0
Quicksilver, per bottle	6	17	0	6	17	0	6	17	0	6	17	0
TIN PLATES.												
IC Charcoal, 1st qu., per box	1	10	0	1	12	0	1	10	0	1	10	0
IX „ „ „	1	16	0	1	18	0	1	16	0	1	16	0
IC „ 2nd qua., „	1	6	0	1	8	0	1	6	0	1	6	0
IC Coke, per box	1	4	6	1	4	6	1	4	6	1	4	6
IX „ „	1	10	6	1	10	6	1	10	6	1	10	6

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Morgan v. Fuller, Feb. 14.—In this case it was sought to restrain the defendants, who are coachbuilders at Bath, from infringing the plaintiff's patent for "improvements in carriages," consisting in the application of apparatus for opening and closing the heads of carriages. According to the plaintiff's plan, the movable heads of the carriage are moved back or raised by levers, which are actuated by cranks and rods concealed within the lining of the carriage, and operated on by a handle turned by the driver, who does not require the assistance of another person to open or close the carriage, the handle being fixed at his side. This handle acts upon a second, and works the heads of the carriage to and from one another by means of head-joints. According to the defendant's plan (patented in 1864 by Mr. Martin) a similar result is obtained by an endless wire rope wound around a pulley acting upon the heads to be lifted. Three questions were at issue in this cause. The first two issues, viz., the novelty of the plaintiff's invention, and sufficiency of his specification, Vice-Chancellor Wood decided in favour of the plaintiff; upon the third, his Honour was of opinion that the defendants had not used head-joints, but adapted a *bona fide* different process for effecting the same results, and not merely a "colourable equivalent." Practically the case was thus decided in favour of the defendants.

The Rights of Individual Debenture Holders.—Bowen v. the Brecon and Merthyr Tydvil Junction Railway Company.—In this case the very important question had to be tried, for the first time, whether one of several debenture holders in a railway company can, by proceeding at law to judgment in respect of his debt, obtain by means of an execution levied upon the rolling stock and chattels of the company, a priority over the debenture holders. The plaintiff was one of the debenture holders in the Brecon and Merthyr Tydvil Junction Company, and had instituted this suit on behalf of himself and all the other debenture holders of the company who held securities similar to his own, to obtain payment of their debts; and in December last a receiver of the undertaking of the company was appointed in the suit by the Court. Shortly after, the petitioner, not being a party to the suit, but a debenture holder of the same class as plaintiff, recovered judgment at law against the company in respect of his debt, and now prayed that, notwithstanding the appointment of the receiver, he might be at liberty to issue execution in respect of his judgment, and realise his debt out of the rolling-stock and chattels of the company. On Feb. 19 Vice-Chancellor Wood delivered judgment. In his opinion the petitioner would have been entitled to issue execution, had he been a simple contrator who had recovered judgment at law; but being a mortgagee, who had accepted his security under the provisions af the 42nd section of the Companies' Consolidation Act, the right of all the co-interestees would be compromised by enforcing a *pars pro toto* judgment. Thereupon his Honour decided as follows:—"The Court being of opinion that the petitioner is not entitled to issue execution in respect of his judgment otherwise than as a trustee for himself and all other the debenture holders who are entitled to be paid *pari passu* with him, let an inquiry be directed at Chambers, whether it will be for the benefit of the debenture holders that any proceedings should be had or taken by the receiver appointed in the case for the purpose of making such judgment

available for the benefit of such debenture holders." Although this judgment bears no definite character, we think it but right to record it, on account of the paramount importance of the question at issue.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Petroleum as Steam Fuel.—The trials made with Mr. Richardson's petroleum boiler in Woolwich Dockyard have resulted satisfactorily. During the latter period of the experiments an evaporation of as much as 18·91lbs. of water with one pound of creosote was arrived at. The trial lasted seven hours. The new fuel gave off at times a great deal of smoke, emitting a most offensive effluvium, the construction of the boiler being such as to impede a full gaseous blast sufficient to consume the smoke, as intended. It is proposed to use a large common marine boiler in future. Naval engineers are of opinion that with such fuel gunboats would be rendered habitable and comfortable in the tropical seas.

Protection for Inventors at the Paris Exhibition.—The French Government, in order to protect poor inventors who have not the means of taking out patents, and who must take advantage of the Exhibition to make their inventions or new processes known, have just laid before the Legislature a bill, which is the reproduction of that of May 2nd, 1855. This measure empowers the Imperial Commission to deliver to every exhibitor who may require protection for an invention, a process, or a design, a gratuitous certificate, or petty patent, which will afford the protection of a full patent for the space of one year from the opening of the Exhibition. In 1855 no less than 600 exhibitors took advantage of the temporary certificate, or petty patent.

The Shipping Trade of the United Kingdom.—By the side of the returns lately published of the tonnage of ships owned in Great Britain and Ireland, and of which we gave an abstract in the Artizan of February last, we doubt not the following numerical data respecting the gradual development of the British maritime trade in the last 25 years, will be interesting to most of our readers. We are indebted for them to Mr. J. B. Redman, of Westminster Chambers, who compiled them from the tables prepared by the statistical Department of the Board of Trade:—

1. Total tonnage of British and Foreign vessels with cargoes and in ballast, engaged in foreign trade, entered and cleared at ports in the United Kingdom.

	Tons Entered.	Tons Cleared.	Total Tons.
1840	4,657,795	4,781,872	9,439,667
1845	6,045,718	6,031,587	12,077,305
1850	7,100,476	7,404,588	14,505,064
1855	8,951,239	9,538,231	18,489,470
1860	12,172.785	12,516,507	24,689,292
1865	14,317,886	14,579,206	28,897,092

So that in 25 years the trade of the country has trebled itself.

2. The same with cargoes only. Both tables include repeated voyages.

	Tons Entered.	Tons Cleared.	Total Tons.
1840	4,105,207	3,392,626	7,497,833
1845	5,023,588	4,309,197	9,332,785
1850	6,113,696	5,906,978	12,020,674
1855	7,018,468	8,348,664	15,367,132
1860	10,054,981	10,782,937	20,837,918
1865	12,158,694	12,827,151	24,985,845

This is a better exemplification of actual trade, and shows a still higher rate of increase. When it is considered that the ports of London and Liverpool deal with nearly one-half of this enormous tonnage their relative progress is significant.

3. Foreign trade with cargoes and in ballast, including repeated voyages.

London.

	Tons Entered.	Tons Cleared.	Total Tons.
1700	157,035	96,244	253,279
1798	627,087	509,534	1,136,621
1825	1,060,687	768,802	1,829,489
1850	1,904,948	1,384,683	3,289,631
1855	2,420,586	1,948,699	4,369,285
1860	2,981,410	2,294,633	5,276,043
1865	3,646.142	2,627,809	6,273,951

Liverpool.

	Tons Entered.	Tons Cleared.	Total Tons.
1825	537,302	555,131	1,092,433
1850	1,605,315	1,656,938	3,262,253
1855	2,074,168	2,223,044	4,297,212
1860	2,773,439	2,899,474	5,672,913
1865	2,644,821	2,631,827	5,276,648

These two tables show the keen competition between the two great rival ports. The coasting trade of the United Kingdom shows a considerable increase of late years, indicative of the increased commercial communication within the realm by sea, and this coincident with the great increase by railways.

4. Coasting trade of the United Kingdom with cargoes only, and including repeated voyages:—

	Tons Entered.	Tons Cleared.	Total Tons.
1850	12,564,631	13,640,526	26,205,157
1855	12,190,002	13,084,475	25,274,477
1859	16,532,117	16,509,471	33,041,588
1365	18,321,642	18,003,577	36,325,219

5. The importation of coal into the port of London gives the following remarkable results:—

	Tons Seaborne.	Tons Inland.	Total Tons.
1850	3,553,304	84,575	3,637,879
1855	3,016,868	1,162,487	4,179,355
1859	3,299,170	1,210,766	4,509,946
1865	3,161,683	2,741,589	5,903,272
1866	3,033,193	2,980,073	6,013,266

In the year 1850 the importation of sea-borne coal into London obtained its maximum, and has since gradually, but progressively, declined; and the inland importation, now mainly by railway, has continued to increase in a much higher ratio. These figures are obtained from the carefully-prepared annual accounts of Mr. James Scott, of the coal market.

MILITARY ENGINEERING.

The Comparative Merits of Various Breech-Loaders.—For some time past a commission of military officers, appointed by the State of New York, has been in session in New York city, examining breech-loading small arms. They have examined all the breech-loaders brought before them, testing the merits of each; and, with regard to the performances of the most meritorious weapons, they report:—The Roberts breech-loader fired 84 balls in six minutes, an average of 14 in one minute, all striking inside the target, and penetrating 15 one-inch planks laid side by side. The Sharpe rifle fired 100 balls in less than seven minutes, and penetrated the thirteenth plank. The Millbank rim-fire gun fired 99 balls in six and a-half minutes, and penetrated the eleventh plank. The Lamson gun fired 12 balls in one minute. Ball's carbine expelled 75 balls in nine and a-half minutes. The Prussian needle-gun, which was tested in the same way as the others, fired an average of six to seven balls a minute, and penetrated the eleventh plank. The Remington breech-loader fired 100 balls in six minutes and fifty-five seconds, and penetrated the eleventh plank.

Patents for Small-Arms by Officers.—In the sitting of the House of Commons of Feb. 11, Lord Longford, the Under-Secretary of War, stated, in reply to a question put by Lord Lifford, that he was not aware that any departmental officers had taken out patents for small-arms, though he believed that a gentleman in the Enfield factory had registered a patent for some improvement in the Schneider rifle, but had subsequently abandoned it. Colonel Boxer had taken out a patent for an improved cartridge. The War Department always discouraged the taking out of such patents by officers, but no formal prohibition had been issued on the subject. It was an element of difficulty that, whereas the War Department objected to patents under such circumstances, the Board of Admiralty did not, and, on being referred to, declined to concur with the Secretary of War in issuing a general prohibition. It appears that General Peel, previous to his resignation, took various steps, from which it would result that in future departmental officers would no longer be permitted to take out patents in relation to improvements coming under their official notice. It is to be hoped that General Peel's successor—Sir John Pakington—will not endorse the views of the former, but allow his subordinates full liberty to avail themselves of the provisions of the Patent Law Amendment Act, like anybody else.

Railway Engineers in the Austrian Army.—The experience of the last campaign has led to the organisation of a special corps of railway engineers in the Austrian army. The staff is placed under the orders of a superior officer of the Engineers, who will have at his disposal a certain number of officers of that service. These will have to make themselves thoroughly acquainted with the technical work on railways, so that, in case of war, they may be able to promptly destroy or re-establish sections of lines, or to interrupt or restore the traffic, as necessity may require.

Silk Gauze for Cartridges.—The French Ministry of War has just announced that an adjudication will be made of 105,000 metres (115,000 yards) of *gaze-de-soie*, to be manufactured in Lyons. The stuff is to serve in making the cartridges for the new Chassepot gun.

Daulle's Multitubular Cannon.—General Daullé, of the French Military Engineers, gives an account of a cannon with divergent tubes, designed to throw musket balls. According to his plan, the number of these tubes will be in proportion to their calibre, and they are so arranged that at a distance of 600 metres the balls will be spread over a space of 15 metres, and at nearly equal distances from each other. The charge of powder is calculated to propel two balls at once from each tube, the trajectory of which will be the same as that of a large projectile from the same cannon. Thus, a field-piece will be capable of holding 16 tubes, and discharging 32 balls at once, which at a distance of 600 metres will strike upon a space occupied by 50 men in two ranks, those of the second rank being liable to be struck by the balls which have passed through the first. This new cannon is to be of iron, the durability of which is greater for the purpose than bronze.

Cornish's Breech-Loader.—The distinctive features of Mr. Kenneth Cornish's breech-loading gun, lately tried at Beaufort Grounds, are as follows:—Across the barrel, at a point somewhat higher up than where this joins the stock, is the breech-piece, being a species of flap, set on edge, and in shape and action not unlike the knife of a guillotine. This is simply lifted up, or pressed down, as occasion may require; and when raised, by pulling it open somewhat further than it would go of its own accord, the extraction, worked by a sere spring, is set in motion, and draws; or, if the motion communicated be quick and sudden, throws out the copper-based cartridge from the barrel. It is part of Mr. Cornish's theory that cartridges made of metal, and on the central-fire principle, are more effectual in rendering military weapons gas-proof than any ingenious construction of the breech itself; since the fittings, however accurate originally, must be disarranged as the weapon heats. Hence, he contends that, using cartridges with a metallic base, the mechanism of the breech may be much simplified and cheapened, since the breech has only to support the rear of the cartridge-case—which is, in fact, an inner barrel—during the explosion, and not to keep in a subtle and imprisoned gas. The needle works through the breech-piece, and hence is short, and not liable to get out of order. It is claimed that the cost of the gun, when new, will not exceed that of an ordinary Enfield, and that the process of conversion is cheaper by some shillings and capable of being effected faster than by any other combination.

NAVAL ENGINEERING.

Remarkably Fast Steaming of a Clyde Steamer.—The paddle-steamer *Buffalo* left Greenock, on a trial trip to Londonderry on the evening of the 21st ult., and reached her destination in 8¾hrs. The distance is about 135 miles, giving an average rate of speed of about 16 knots, or nearly 19 miles an hour.

The "Dunderberg."—The iron-clad ram *Dunderberg*, built by Mr. W. H. Webb

made her trial trip in New York Harbour, on Feb. 22 and 23. This vessel is practically a floating fort. Her dimensions are as follows:—Extreme length, 380ft. 4in.; extreme beam, 72ft. 10in.; depth of main hold, 32ft. 7in.; height of casemate, 7ft. 2in.; length of ram, 50ft.; draught, 21ft.; displacement, 7,000 tons; tonnage, 5,000 tons; weight of iron armour, 1,000 tons. The engines are two in number, of 5,000 horse-power in the aggregate; diameter of cylinders, 100in.; stroke of pistons, 45in. She has six main and two donkey boilers, weighing in the aggregate 250 tons; boiler surface, 30,000ft.; grate surface, 1,200ft.; condensing surface, 12,000ft. The diameter of her propeller is 21ft., its pitch 30ft., its weight 35,000lbs. The capacity of her coal bunkers is 1,000 tons. The bottom of the hull is flat, the sides angular; the hull is built of layers of square logs, bolted together. Upon the hull the casemate, or fighting-room, is built of square logs, each one foot in thickness, and rises to the height of 7ft.; it is covered with a bomb-proof deck. The hull is covered with a planking 5in. in thickness; outside the planking is a covering of logs; this covering is at the bilge 3ft. in thickness, at the water line 6ft., and at the top 7ft. The armour consists of 4½in. plates, laid on vertically; the side armour is of hammered iron; the plates are secured to the log-covering by bolts 18in. in length, firmly screwed into the wood; the main deck is covered with 4½in. plates. The most formidable feature is the ram, which is 50ft. in length. This ram is simply an elongation of the vessel itself. It is constructed of heavy logs, plated with a wrought-iron jacket; in shape it resembles a knife blade. The armament of the vessel, when complete, will consist of eighteen 11in. and 15in. Dahlgren and Rodman guns, six of the latter description. At present, however, the vessel carries but six guns, two of them being 15in. Rodmans. There are several well-constructed bulkheads. The keel, keelsons, rudders, and stern are in the same ponderous proportion as the rest of the vessel. The engine-rooms, coal-bunkers, and magazines are well protected. The *Dunderberg*, unloaded, drew 16ft. of water forward, 21ft. aft; with the full armament on board, or twelve additional guns, with complement of shot and shell, and with full coal bunkers, the draught of water would evidently be much greater. The highest rate of speed attained by the *Dunderberg* during the late trip was 11 knots 6 fathoms: the sea was smooth, however, so that the qualities of the vessel were not fully tested. Four minutes only were occupied by the *Dunderberg* in turning; a complete circle was made, within the space of half a mile, in thirteen minutes. This is the best that can be said of Mr. Webb's *chef d'œuvre*. The reverse side of the story is not so flattering. The engines did not work satisfactorily. After a few turns the journals became red-hot, and if a constant stream of cold water had not been applied, these massive brasses would have melted and flowed like lead. The journals were incessantly deluged with water from a hose 1in. in diameter. In twenty-four hours an entire barrel of oil was used up in the lubrication of other portions of the machinery. The guns were fired several times. The effect of the concussion was startling. The wooden bulwarks on the main deck were shattered to splinters. The heavy skylights were driven in and downwards. The builder of the *Dunderberg*, Mr. W. H. Webb, contracted with the United States Government to furnish the vessel for 1,250,000 dollars, and he has already expended 2,500,000 in her construction. The Government has heretofore refused to accept the vessel, contending that the contract had not been fulfilled. During the late trial trips a committee of Government officers inspected the working of the *Dunderberg*, and the Government will act upon their report. If the vessel is finally rejected by the United States, Mr. Webb will endeavour to make a transfer to some foreign Government. It was reported a few weeks ago that the Prussian Admirality were desirous to add this vessel to the North German Navy, and Prussian naval officers had been sent to New York to inspect and report on the *Dunderberg*. However, it is assumed that, owing to the want of success of the trial trip, the Prussian Government will reconsider their resolution. Under these circumstances, it is doubtful whether Mr. Webb's vessel will find any purchaser at all.

SHIPBUILDING.

Shipbuilding in the United States.—The anomalies from which the labour market in the United States is suffering and to which we drew attention in our last issue, are felt most heavily in the shipbuilding and cognate engineering trades. The prohibitive tariff bill which had passed the Senate, has been quietly shelved by the House of Representatives; yet the tariff at present in force is sufficient to increase three or four fold the price of all materials requisite in shipbuilding, and thus paralyze an industry, which, but a few years back, stood foremost and was the most flourishing of all industries in America. An idea of the present state of the case may be formed from the following particulars, given by the New York correspondent of the *Morning Herald*:—"The great decline in American shipbuilding is at last beginning to awaken public attention. It is discovered that the business is at a complete standstill in this port, and that scarcely anything is being done in any of the New England ports. Various explanations of the causes of this misfortune have been offered, but the most practical are those volunteered by W. H. Webb, a well-known shipbuilder of this city. Mr. Webb gives four reasons for the stagnation—the high cost of labour, the high cost of material, the high tariff, and the lack of skilled workmen. Labour has advanced in cost at least 75 per cent., and the advance in the cost of material is not much less. A convention of shipbuilders of New England has just been held in Bath, Maine; little else was done by the convention, however, than to memorialise Congress for relief, and to show that the shipbuilding interest had been well-nigh fatally injured by the competition in the British provinces. Unpleasant as it may seem, Americans may as well make up their minds for the loss of the shipbuilding trade as a branch of Yankee industry. Congress has attempted to avert this disaster by providing, in the Tariff Bill, for a drawback equal in amount to the duty on materials used in shipbuilding imported into the United States. This will afford only partial relief. By no act of Congress can the cost of labour be brought to its old standard. Mr. Welles has shown that the cost of building a ship in the port of New York is at least 100 dollars (in currency) per ton, while the cost in St. John, New Brunswick, is at the highest not above 50 dollars (in gold) per ton. If, with the drawback proposed, the cost in New York could be reduced to 80 dollars per ton, the St. John shipbuilder would still have the advantage. In Bath, Maine, the cost of a ship of 1,000 tons is 41,428 dollars; in St. John as good a vessel can be built for 26,000 dollars, and the cost in Bath is much less than that in New York. American shipowners, therefore, will naturally turn to the British provinces, for their patriotism is not so great as to prompt them to throw away 15,000 dollars on a single vessel of 1,000 tons burden. We have no remedy but to submit; we made the high prices, and we alone must suffer the evils of high prices." We doubt not the resumption of their places in the National Representation by the Southern States, every one of which is favourable to free-trade, will restore the normal state of things that has been disturbed for several years past by a sectional Congress, and put a stop to the decline of American trade and industry; which will, at least in the Atlantic States, go to rack and ruin, if reconstruction be delayed any longer.

Shipbuilding on the Clyde.—During the past month an important accession has been made to the strength of our mercantile navy by the launching of several large steam and sailing vessels from shipbuilding yards on the Clyde. Amongst the most important of the former may be mentioned the Cunard steamer *Russia* (3,141 tonnage), the *Weser* (2,900 tonnage), and the *Bungalore* (2,300 tonnage). The particulars of these vessels will be found in another page. Amongst a few of the sailing vessels launched may be mentioned the composite ship the *County of Elgin* (895 tonnage), built by Messrs. Charles Cornell and Co., at their west shipbuilding yard, at Overnewton; and an iron barque, of 450 tonnage, the *Pacific*, built by Messrs. Alex. Stephen and Sons, Kelvinhaugh. This vessel is to be employed between Swansea and Valparaiso, in the copper ore trade, for which she has been specially constructed.

ACCIDENTS.

On the Scottish North-Eastern Line, near Aberdeen, a serious collision took place on February 11th. The express train from the south, due in Aberdeen at ten minutes past four, was trying to make up for lost time, when, on getting within about three miles of Aberdeen, the engine jumped off the line, and, with tender and carriages, immediately blocked up both lines of rails. A mail train from Aberdeen was due to pass the spot at the moment, and before anything could be done it came down upon the ruins of the southern train. Fortunately the driver of the mail train shut off steam and jumped from his engine the moment he saw that a collision was inevitable, and the result was that the shock was much less than could have been expected, the injury to the passenger being confined to cuts and contusions. The enginemen and passengers of the southern train were not seriously hurt by the tumbling about of the carriages, consequent on the train getting off the line, and they had time to get clear of the line before the collision with the mail train.

Accident to the Clyde Steamer "Earl of Dublin."—We regret to learn that this splendid new paddle steamer went ashore near Ballyhalber, on the Irish coast, on the morning of the 22nd ult., during a severe gale, accompanied by snow, and we fear has by this time become a total wreck. She was on her second voyage to Dublin when the accident occurred. The passengers were all got off in safety. The *Earl of Dublin* was launched from the building-yard of Messrs. Robert and Co., Port Glasgow, in November of last year. Her engines, which were of 300 horse-power, were supplied by Messrs. Rankin and Blackmore, Eagle Foundry, Greenock. On her trial trip to Dublin, some three weeks since, she ran the distance from Greenock-quay in 11hrs. 55min., being the quickest passage, we believe, which has been made on this station.

MINES, METALLURGY, &c.

Electricity in Mining.—The electric telegraph has been successfully introduced to mining operations, by means of which a serious impediment has been overcome. The shaft of the Trafalgar Colliery, in the Forest of Dean, terminates on the vein of coal; from thence the coal has has been worked to the "dip," leaving a formidable incline for the coal-waggons to ascend, and increasing the expense of working. A steam-engine was erected on "the bank," to reduce the expense of haulage, and to increase the despatch. Its usefulness was considerably interfered with by the loss of time in communicating the required signals. Mr. W. B. Brain, the engineer has introduced the electric telegraph, by which signals are at once transmitted to the engine-house, and the words "go on" and "stop" are instantly brought into view. The instrument was made by Mr. Izant, of London.

RAILWAYS.

Railway Bills in Parliament, 1867.—The number of railway bills deposited for the present session is 155, of which 68 authorise new lines. The number of bills promoted by new companies is 16, of which 14 are for 95 miles of railways in England, and two for 12 miles in Scotland; total, 107 miles. The number of bills promoted by existing railway companies is 52 for the construction of 257 miles of rail, viz., 220 miles in England, 26 in Scotland, and 11 in Ireland. Aggregate length of proposed new lines before Parliament, 364 miles, of which 315 are for England, 38 for Scotland, and 11 for Ireland. Moreover, 51 miles of deviation lines and 40 miles of tramways for streets are proposed.

TELEGRAPHIC ENGINEERING.

The Overland Telegraph to China.—On Feb. 20th, the telegraph and courier service to China, *via* Kiachta, was re-opened. This line in twelve days conveys messages from London to Tien-tsin, the seaport of Pekin, from whence they are despatched to any port in China. As the line is not blocked up by a large number of messages the delays and non-delivery experienced with the Indian service are avoided, and the messages delivered in a more intelligible shape. The cost for twenty words amounts to £4 7s. 6d. from London to Tien-tsin.

DOCKS, HARBOURS, BRIDGES.

Railway Bridge on the Lower Rhine.—The Bergisch-Märkische Railway Company have received permission to construct a railway bridge across the Rhine at Hamm, near Düsseldorf. Like the Strasburg, Coblenz, Mayence, and Cologne bridges, it is so to be built so as to admit of the principal pillars being blown up at any moment. The arrangements are to be such that the explosion extending equally below the water as above, will prevent the bridge from being easily repaired. Fortifications to be erected in front, in accordance with the royal order, must be strong enough to secure the bridge from a *coup de main*, and be tenable at least as long as is required for laying and firing the trains.

The High Level Bridge at Longhedge.—An operation of some interest was carried out lately by Mr. James Haywood, of Derby, the contractor for the ironwork for the new line of the London, Brighton, and South Coast Company, at Battersea, under the instructions of Sir Charles Fox and Sons, the engineers in charge of the works. The new high level line is intended to cross the low-level railway at Longhedge by a bridge of 120 feet span. This bridge has two main girders of lattice work, 11ft. deep and 126ft. long. In consequence of the increasing traffic at this point during the day, it was impossible to erect a staging across the line; the iron girder was, therefore, put together on the adjoining viaduct, and cross lines having been laid across the railway to carry a strong trolly or moveable tressle upon eight wheels, one of the main girders was successfully rolled over during the nights of Feb. 26 and 27, about eleven hours being occupied with this operation. The great weight of the girder, with its want of lateral stiffness, and the very short time allowed for the work, rendered this a matter of some difficulty, but it was carried out with perfect success.

Harbour Accommodation at Glasgow.—For a couple of years past there has been in course of construction a tidal basin, intended to relieve the existing pressure of shipping in Glasgow harbour. It is situated on the south side of the Clyde, about half a mile below Broomielaw Bridge. It occupies an area of 5½ acres, and affords some 830 yards of commodious quays, on which sheds will be erected for the reception of merchandise. On the 7th March, for the first time, the tide was allowed to flow in. A dredger will be forthwith introduced, and the basin scraped out to a depth of 22ft. below high water of spring tides, being the present average depth of the Glasgow harbour. It is expected that in eight months from the present date the basin will be in a state to receive shipping.

APPLIED CHEMISTRY.

Action of Peroxide of Manganese on Salts of Copper, by M. W. Schmid.—By shaking peroxide of manganese with a solution of sulphate of copper, a peroxide, CuO_2, is gradually produced, and the manganese dissolves. At the end of three weeks the exchange will be completed, and the filter will retain only a cupreous compound, nearly free from manganese. It is hardly necessary to say that the manganese employed must be perfectly pure. The exchange is made equivalent for equivalent. The peroxide of copper thus formed produces a strong effervescence when, after it has been moistened with a few drops of water, a little sulphuric acid is added. A similar peroxide has been obtained by Thénard by treating oxide of copper with oxygenated water. This is an antozonide, while peroxide of manganese is classed by M. Schönbein among the oxonides —*Chemical News*.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated February 6th, 1867.

335 W. Rigg—Securing oil and other liquids in cans
336 W. E. Newton—Bobbins for spinning machinery
337 J. Graham—Manufacture of spelter from zinc ashes, &c.
338 A. B. Brown—Drilling machines
339 W. Prangley—Apparatus employed in athletic exercises
340 F. Rosenauer—Stiffening yarns, &c.
341 J. S. Hoar—Bench vices

Dated February 7th, 1867.

342 J. Ramsbottom—Supporting, moving, and forging heavy masses of metal
343 W. G. Beattie—Slide valves
344 G. E. Pain and C. Corroy—Oils for illuminating and other purposes
345 S. Howard—Pressing and shaping hats, &c.
346 R. E. Green and W. Laycock—Printing on textile fabrics
347 W. T. Carrington—Steam rollers
348 E. Siddaway—Charcoal box smoothing irons
349 H. K. York—Heating with hot water
350 F. C. Lesder—Venetian blinds
351 W. Clark—Attaching teeth to saws
352 W. Clark—Mechanical movements to be applied to automaton toys and hobby horses
353 W. Couisbee—Locking up type, &c.
354 H. E. Falk—Steam boiler and other furnaces for the better combustion of fuel

Dated February 8th, 1867.

355 W. Kilbee—Breech-loading firearms
356 E. Firth—Fabric in imitation of the skins of animals
357 M. J. Hains—Leather straps and driving bands
358 W. S. Losh—Manufacturing a salt or salts of ammonia
359 A. Ormsby—Collection and storage for distribution of rain water
360 T. Sibley—Machines for washing and churning
361 H. A. Fletcher—Boring and planing metals
362 J. H. Johnson—Propellers for ships, &c.
363 D. N. Defries—Gas burners
364 P. E. Gaiffe and A. A. Lalance—Electro engraving
365 W. Jones—Shaping metals
366 T. Gill—Doubling frames for yarns

Dated February 9th, 1867.

367 J. Stanton—Self-acting safety gun lock
368 R. Haworth and J. W. Welch—Sizing, dressing, and beaming yarn and thread
369 G. Daws—Opening, closing, locking, and unlocking cart and other gates on railway level crossings, with signals in connection therewith
370 T. R. Jones—Combined bench and desk
371 J. Brigham and R. Bickerton—Reaping and mowing machines
372 E. A. Kirby—Portable miniature dispensary, &c.
373 E. Heywood and E. Hinchcliffe—Producing fancy weavings
374 F. Leonardt — Boxes for containing metallic pens, &c.
375 J. Buhrer—Generating steam, and apparatus employed therein
376 R. James—Steam boilers
377 C. W. Dixon—Mounting wheels on axles
378 E. Gorges—Preserving meat, &c.
379 W. Clark — Preserving animal or vegetable matter
380 A. G. Grant—Exhibiting moving and other pictures

Dated February 11th, 1867.

381 R. B. Mulliner—Shoes for horses
382 P. D. Collins—Self-closing bottle stopper and key
383 G. H. Kidd—Regulating the supply of water to cisterns, &c
384 R. T. Thompson—Studs and buttons and their fastenings
385 W. E. Newton—Treating vegetable substances

Dated February 12th, 1867.

386 J. Ramsbottom—Transferring engines, &c., from one line of rails to another
387 E. Manico—Raising sand or shingle
388 W. Stratford—Carriages, &c.
389 E. H. Beruier—Safety apparatus for raising and lowering heavy bodies
390 J. B. Booth—Carding engines
391 Sir J. Y. Simpson—Utilising of mineral and other oils for the production of heat, &c.
392 J. H. Johnson—Breech-loading firearms
393 W. Clark — Obtaining and applying motive power
394 W. H. Towers—Preparing raw hide
395 F. Bacon—Breech-loading firearms
396 A. V. Newton—Sewing machines
397 H. H. Grierson and J. McElroy—Governors for steam and other motive power engines
398 W. Clissold—Tentering machine

Dated February 13th, 1867.

399 A. J. Paterson—Firearms, &c.
400 J. Westwood and R. Baillie—Iron safes, &c.
401 J. Westwood and R. Baillie—Iron piles and columns
402 W. E. Gedge—Steam boilers
403 W. Clark—Moulding and pressing bricks
404 H. Houfe—Outside lamps for shop fronts, &c.
405 S. D. Mack—Cleaning wheat, &c.
406 W. Jones—Lamps
407 W. E. Newton—Taking photographic portraits, &c.
408 S. Osborne—Stays, corsets, &c
409 H. A. Davis and S. J. Salkeld—Drawing liquids from casks, &c.

Dated February 14th, 1867.

410 J. Thompson—Cutting and polishing metals
411 J. Walton and R. Harlow—Tilting barrels
412 H. A. Dufrené—Holder for railway and other tickets
413 H. A. Dufrené—Railway and other tickets
414 J. V. Toepken—Packing a certain kind of friction match
415 G. Ireland—Cruet frames
416 D. Tenniswood—Boot and shoe toe pieces, &c
417 G. W. Wright—Street gutters and sinks
418 T. Greenwood and F. Keates—Boots and shoes

Dated February 15th, 1867.

419 R. George—Cinder shovels
420 J. P. Kerr and W. McGee—Chain beaming apparatus
421 W. J. Knowles and J. E. Wilding—Rollers
422 R. Shaw—Motive power engines
423 J. Capper—Chimney top
424 P. Duchamp—Drawing of liquids and supplying them to bottles
425 J. Lamble—Coating and preservation of ships' bottoms
426 J. Combe — Drawing fibrous substances in drawing and spinning frames
427 T. W. Nicholson—Improvements in and adaptation of cylinder printing machines to the double purpose of letter press and lithography, &c.
428 J. Ferrabee—Feeding carding machines
429 A. V. Newton—Water meter

Dated February 16th, 1867.

430 E. Lord—Looms for weaving
431 J. Shaw—Spinning and doubling cotton, &c.
432 J. Carter — Opening, closing, and securing portholes of ships
433 G. White—Levelling and certain other mathematical instruments
434 H. Cooper—Dining table
435 J. Parkes—Instrument for giving answers to selected questions
436 E. Stevens—Means to secure coal plates, &c.
437 E. Stevens—Cans, kettles, &c.
438 R. Hodson — Punching iron and other metal plates

Dated February 18th, 1867.

439 W. Hill and H. C. Wilberforce—Gas cooking apparatus, &c.
440 R. Thwaites, E. H. Carbutt, and J. Sturgeon—Hammers to be worked by steam or other fluid
441 Count A. Dillon—Recovering ships
442 W. H. Harfield—Windlasses
443 W. E. Newton—Corsets

Dated February 19th, 1867.

444 C. Wanner — Preventing down draught in chimneys
445 G. F. Redfern—Breech-loading needle firearms, and cartridges for the same
446 A. A. Fouaset—Patent leather, &c.
447 H. Haschke — Breech-loading firearms, and cartridges for the same
448 A. Beuiest—Regulating the movements of steam engines
449 H. Alder—Gas meters
450 E. Brasier—Scutching flax, &c.
451 E. Brasier—Manufacture of oakum from old ropes, &c.
452 H. Y. D. Scott—Constructing the floors and roofs of houses, &c
453 A. V. Newton—Railroad switch indicator

Dated February 20th, 1867.

454 W. Harrison—Consuming smoke in furnaces
455 M. Cavanagh—Adjustable lock spindles
456 T. Archer—Breaking and grinding stone ores
457 J. S. Walker—Undermining, holeing, and cutting coal
458 J. H. Johnson—Application of certain hydrocarbons to the obtainment of light and heat, and means employed therein
459 R. Moreland—Floors for buildings
460 A. Albini and F. A. Brsendlin—Breech-loading firearms
461 C. Weigand—Umbrellas and parasols
462 R. Kunstmann — Cleaning and polishing the surface of glass
463 G. Haseltine—Letting on and shutting off gas and igniting the same
464 G. Haseltine—Boat detaching apparatus
465 W. R. Lake—Files, and handles for the same
466 M. Henry—Balloons, etc.

Dated February 21st, 1867.

467 W. S. Gamble—Lubricating apparatus
468 J. Bishop—Breech-loading firearms and ordnance
469 W. B. Adams—Uniting iron and steel in sheets, plates, etc.
470 G. Haseltine—Wheels for carriages, etc.
471 H. Wadkin and C. Shepherd—Burning limestone and cement, etc.
472 E. G. Brewer—Obtaining and applying motive power
473 J. M. Kauffmann—Means to be used for travelling through the atmosphere, etc.
474 J. Weems and T. Robertson—Motive power engines
475 J. Sainty—Fencing for agricultural and other purposes
476 B. Mitford—Teaching alphabets and reading
477 W. Riddell—Disintegrating wood, etc.
478 J. Robinson and J. Smith—Applying motive power to saw frames
479 W. Hale—Propelling vessels
480 J. F. Bland—Breech-loading firearms
481 L. H. Mahon—Working designs in wool

Dated February 22nd, 1867.

482 J. R. Crampton—Rag engines
483 M. Walker, G. H. Money, and F. Little—Breech-loading firearms, and cartridges to be used therewith
484 J. Harrison—Removing seaweed, etc., from the submerged parts of ships, etc.
485 W. West and J. Darlington—Counterbalancing the pump rods in mining operations, etc.
486 C. Colwell—Obtaining motive power
487 W. W. Urquhart and J. Lindsay—Power loom lathes, etc.
488 A. I. L. Gordon—Fastening the wires employed for transmitting electric signals on railway trains
489 C. E. Bronman—Spotted threads
490 J. Wareing—Cricket spikes
491 C. M. Tate—Preparation and application of certain materials to letters, etc.
492 W. Clark—Toilet soaps
493 M. Henry—Railway engines and carriages, etc.
494 C. Kessler—Carbonate of soda and potash
495 W. E. Heath—Gas pressure governors

Dated February 23rd, 1867.

496 T. King—Washing and cleansing casks
497 J. Phillips-Smith—Tilling and cultivating land by steam power, etc.
498 H. Purnell—Motive power engines
499 A. Kinder and W. B. Kinsey—Gas engines
500 W. Deakin and J. B. Johnson—Steel caps for spinning, etc.
501 C. G. Gumpel—Improvements in chairs
502 W. P. Grey—Breech loading firearms
503 H. J. Cole and W. C. Horton—Mechanism to be used for coverings for omnibuses, etc.
504 I. M. Milbank—Breech-loading firearms
505 P. A. Muntz—Manufacture of certain metallic alloys
506 B. Billingham, A. Griffiths, and J. Dudley—Rails for railways, etc.
507 J. Bates—Tallow cup
508 C. Turner—Brushes for brushing hair by rotary motion, etc.
509 C. E. Brooman—Preparation of threads, etc.

Dated February 25th, 1867.

510 G. Luttringhaus—Portemonnaies, etc.
511 J. Marshall—Fluid safety gauges for steam boilers, etc.
512 E. Chapron—Treatment of peat
513 J. Cash and J. Cash—Towels
514 J. C. R. Wegoelin and B. Hirst—Generating steam, etc.
515 W. Barratt—Boiling fats
516 J. Alison—Steam boilers

Dated February 26th, 1867.

517 J. A. Hopkinson and J. Hopkinson—Furnaces for steam boilers, etc.
518 G. Daws—Signalling on railways, and apparatus connected therewith
519 J. Syme—Central fire cartridges
520 W. H. Samson—Drying hops
521 H. R. Do Pre—Improved candlestick
522 W. R. Hill—Chromo eidotrope for dissolving views and optical effects
523 R. Funnell—Alarum for the use of railways
524 E. Hely—Envelopes
525 G. Young—Lamps
526 J. L. Sharman—Lasts for makings boots and shoes
527 C. Martin—Steam engines
528 J. G. Taylor—Chains and fastenings
529 J. Tatham—Preparing cotton, etc., for spinning
530 A. V. Newton—Fastenings for driving, etc.
531 C. E. Brooman—Extracting liquids from substances containing the same
532 C. E. Brooman—Winding up clockwork

Dated February 27th, 1867.

533 G. Haseltine—Covering for horses' feet
534 F. V. Wright—Adjustable reflectors for lamps and lighting purposes
535 A. Huwat—Mining and working coal, etc.
536 W. Stobbs—Steam driving wheel
537 J. R. Cooper—Breech-loading firearms
538 J. Saxby and J. S. Farmer—Regulating railway signals, etc.
539 H. A. Bonneville—Apparatus to deepen, excavate, scour, and remove foul matters from the bed of rivers, etc.
540 T. Humphreys—Fire lighter
541 W. Dyson—Twisting and doubling fibres and threads
542 T. B. Kay and F. Hamilton—Carding engines
543 J. McLintock—Packing for piston rods, etc.
544 S. Butler—Figured lace in twist lace machines
545 L. H. Philhoia and A. Marchal—Springs for crinolines for ladies' petticoats, etc.
546 A. L. Holley—Iron and steel
547 J. Livesey, J. Edwards, and W. Jeffreys—Signal and switch apparatus for railways
548 M. Mackay—Boiling and bleaching all kinds of textile fabrics, etc.
549 A. V. Newton—Railways, etc.
550 A. V. Newton—Screws and bolts
551 A. McDougall—Utilising a certain description of clay, etc.

Dated February 28th, 1867.

552 C. J. Pownall—Ventilating pits and mines
553 T. Hyatt—Securing door or other knobs to their spindles
554 R. E. Guy—Reception of monies paid as fares in vehicles
555 S. Shore—Preparing wool, etc., to be spun
556 A. G. Chalus—Producing artificial light from gas, etc
557 J. Liddington—Inkstands
558 A. McCallum—Actuating motive power engines and apparatus employed therefor
559 A. B. Brown—Steering apparatus
560 S. B. Allen and J. H. Winsor—Generating heat by the admixture and combustion of a hydrocarbon vapour, etc.
561 E. T. Hughes—Brake for sewing machines
562 J. Buhrer—Ovens and kilns for drying and burning bricks, etc.
563 A. A. Croll—Treatment of hydrocarbon oils
564 M. Woolrich—Means employed for the cure of the disease called foot rot in sheep
565 J. Harbert and F. Goodman—Destroying explosive gases in coal and other mines
566 J. Bellerby—Grinding, crushing, hulling, or shelling vegetable produce
567 G. F. Russell—Construction of wheels
568 W. Clark—Producing oxygen, etc.
569 W. E. Newton—Truss supports
570 A. V. Newton—Cutting veneers
571 A. V. Newton—Steam and gas engines

Dated March 1st, 1867.

572 R. A. Jones and J. C. Hedges—Fire escapes
573 J. C. Broadhent—Compound safety disengaging hook
574 J. H. Johnson—Sewing and ornamenting textile fabrics, etc.
575 T. Berrens—Perforating tunnels and galleries of mines through rocks
576 C. H. Beckingham—Billiard tables
577 W. C. Thurgar—Regulating the supply of gas to burners
578 B. Sbeard—Steam boilers and other furnaces
579 W. Parry and J. Frearson—Treating sewage
580 F. A. P. Vandeputte—Universal isochronous pendulum speed regulator for motive engines
581 F. W. Jones—Indicating the speed of railway trains and locomotives
582 J. G. Stidder and R. Morris—Axles, etc.

Dated March 2nd, 1867.

583 M. Gossi — Transporting, warehousing, and barreling petroleum oil, etc.
584 R. Wilson and W. H. Bailey—Call bells, etc.
585 S. Frank and R. Gooddy—Producing selvedge lines on woven fabrics, etc.
586 J. Wild—Condensing steam engines
587 E. T. Hughes—Filtering presses
588 G. M. Garrard—Mowing and reaping
589 A. Illingworth and H. Illingworth—Bobbins
590 E. Thring—Stoves
591 J. A. Coffey—Self-acting steam and fluid safety gauges
592 A. C. Laurys—Fabric for elastic stockings
593 G. Haseltine—Self-lubricating axle for vehicles
594 W. R. Pape—Breech-loading firearms

Dated March 4th, 1867.

595 T. J. Binfield—Fastening the iron bands for packages containing goods
596 W. E. Gedge—Peeling machines
597 W. E. Gedge—Water closets
598 R. E. Keen—Combined reed frame and thread cutter
599 M. A. F. Mennons—Breech-loading firearms
600 E. Deane—Tent poles
601 J. Marchent and J. Parker — Generating and condensing steam, etc.
602 R. E. Waddington—Umbrellas, etc.
603 J. W. Lewis and G. Archbold—Needle cases
604 R. Thompson—Polishing mouldings, etc.
605 S. Newington—Destroying insects, etc.

Dated March 5th, 1867.

606 J. M. Stanley—Metallic front for shirts, etc.
607 J. C. Martin—Packing and preserving animal size
608 H. Ulliel—Artificial light and heat
609 T. Beeley—Steam generators
610 F. H. Jones—Wearing apparel
611 A. S. Macrae—Hydrocarbon oils
612 J. E. Smith—Ornamenting shirt fronts, etc.
613 G. Haseltine—Packing for the joints of steam engines, etc.
614 G. Haseltine—Feed water regulator for steam boilers
615 G. Withy and J. F. Cotterell—Cases for bottles
616 J. E. Duyck—Utilisation of oils for the production of heat, etc.
617 G. Rowley—Miners' safety lamps
618 E. Wells and W. Pryor—Rising brackets
619 G. Haseltine — Repeating breech-loading firearms

Dated March 6th, 1867.

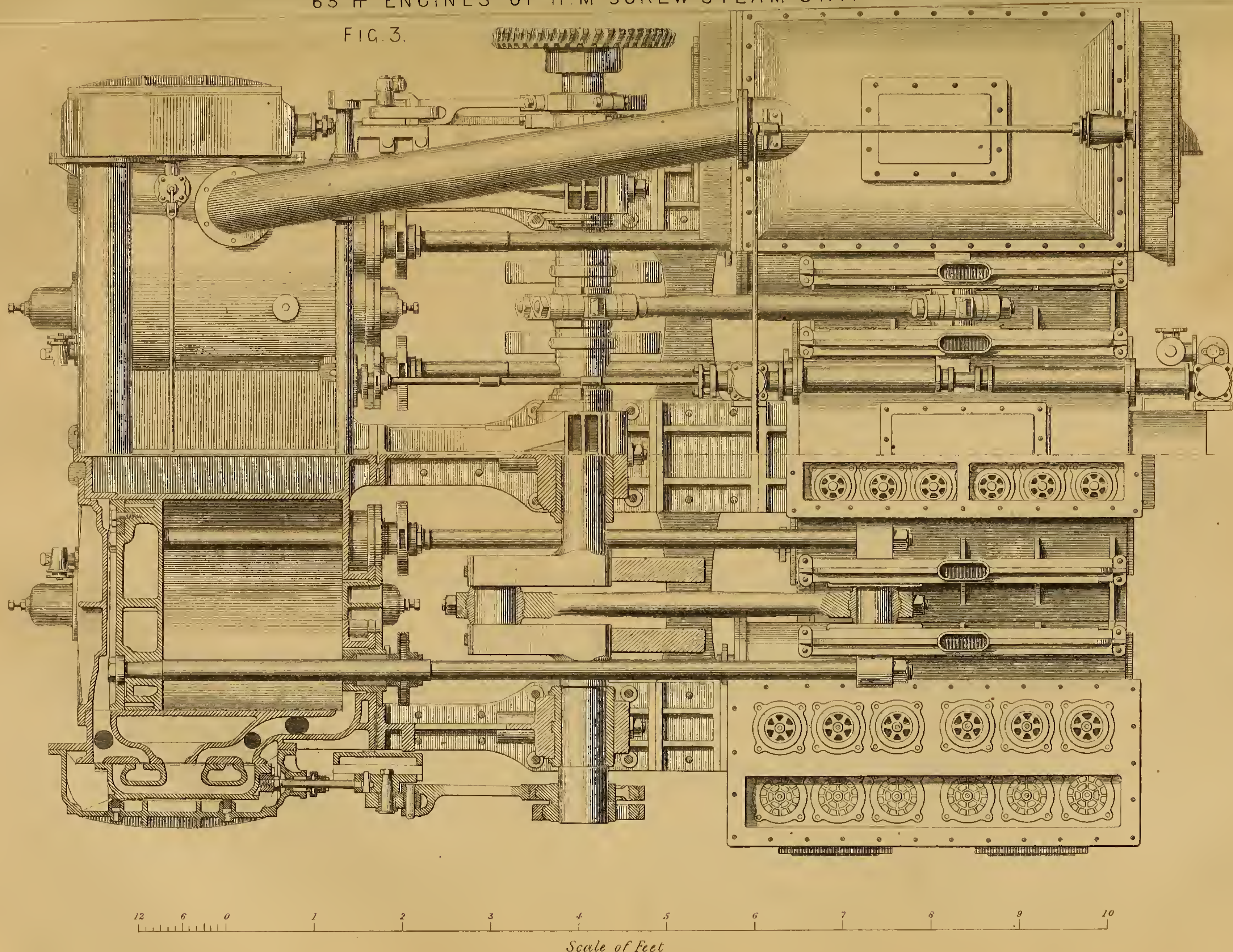
620 J. R. Brecon and R. Dixon—Conveying, screening, and loading coke, etc
621 J. G. Tongue—Steam engines and pumps
622 G. H. Morgan—Carriages
623 W. E. Gedge—Pianofortes
624 J. Thompson—Manufacture of gas
625 H. C. Ash—Cooling and freezing liquids
626 E. Storey—Boilers for generating steam
627 H. Barton and E. Whalley—Spinning and twisting cotton, etc.
628 W. Tomlinson—Apparatus used in connection with calico printing machines
629 H. W. Watson—Producing optical illusions
630 A. V. Newton—Couplings for balling bands

Dated March 7th, 1867.

631 C. W. Siemens—Measuring water, etc
632 G. Davies—Insulators for telegraph wires
633 A. L. Normandy—Engines worked by heated air, etc.
634 W. Higinbottom—Steam boiler furnaces
635 E. K. Heaps and T. P. Moorwood—Fire ranges for dwelling houses
636 I. Dimock and J. Gresham—Sewing machines
637 A. Giles—Mixing apparatus
638 H. W. Achgelis—Bridle bits
639 R. Luke and W. Parkes—Metallic bedsteads
640 Col. S. Wortley—Hatching eggs
641 P. R. Hodge—Hydraulic motors
642 W. E. Newton—Manufacture of porcelain
643 A. V. Newton—Safety valves for steam boilers or generators

65 HP ENGINES OF H.M SCREW STEAM SHIP

FIG. 3.



N Smith C.E direx.

65 HP ENGINES OF H M SCREW STEAM SHIP

EARL DE GREY AND RIPON.

DESIGNED BY Mr H. TURNER

FIG 1

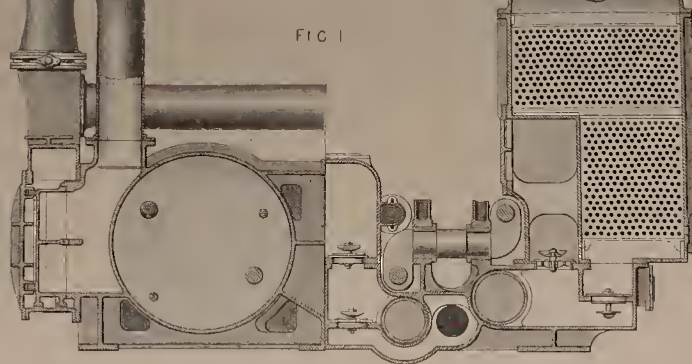


FIG. 2.

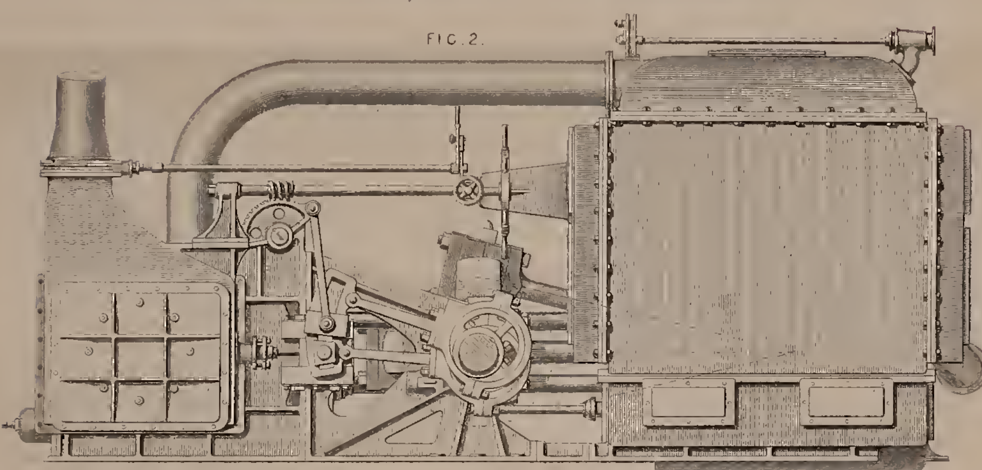
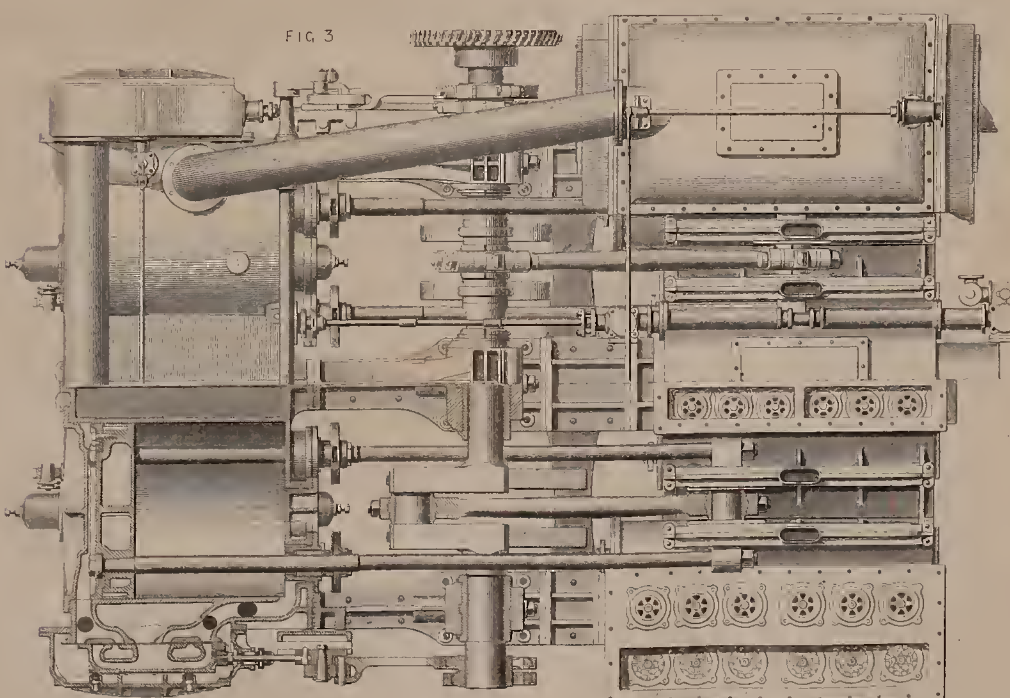


FIG 3



12 6 0 1 2 3 4 5 6 7 8 9 10

Scale of Feet

THE ARTIZAN.

No. 5.—Vol. I.—Fourth Series.—Vol. XXV. From the Commencement.

1st. MAY, 1867.

ENGINES OF H.M. TRANSPORT, "EARL DE GREY AND RIPON."

Designed and Manufactured by the Thames Iron Works Company, Limited.

In consequence of the great increase in number, the keen competition and the increased distances which steam vessels have to travel, the attention of marine engineers has within the last few years been directed principally to the reduction of the amount of fuel consumed per indicated horse-power of the engines, and the lightness and compactness of the engines themselves. In some cases no doubt they have gone too far, and sacrificed strength in order to lessen the weight, and have made the engines so "compact" that the parts were almost inaccessible. Again, in order to obtain the utmost economy of fuel, such varied complications have, sometimes been introduced that the number of parts, and consequently the number of chances of a break-down was greatly increased, besides adding enormously to the first cost of the engine. The economic value of surface condensation has been well-known for the last thirty years, whilst that of superheating has also been pretty generally acknowledged for the last ten years, but, until lately the mechanical difficulties to be overcome were considered insuperable objections, more especially where vessels were required for long ocean voyages, and when they were destined to ports where there were either no facilities for repairs, or even if such facilities existed the charges were excessive. Why surface condensation should not have been more generally adopted many years ago, it is difficult to say, unless perhaps the difficulty of keeping the tubes of the condenser perfectly tight, combined with the increased cost, frightened the majority of steamship owners.

Since Watt first invented the tubular condenser on land engines about ninety years ago, and shortly afterwards gave it up, nothing seems to have been attempted in that way until marine engines, with the necessary accompaniment of salt-water in the boilers, and consequent blowing out every two or three hours, gave a fresh and much greater inducement to engineers to adopt the system. It is now more than thirty years ago that Hall's surface-condensers were tried, but at that time marine engines were sufficiently cumbersome and expensive without having to add any more complications; besides, steam-vessels at that time were only used for short voyages, and economy of fuel, as we mentioned before, was not then of so much importance. When, however, steam began to be used at a much higher pressure, and the system of working expansively was generally adopted, the advantage of surface-condensers was evident, and at the present time the engines of ocean-going steamers are almost universally fitted with them, though, as in the case of the *Earl de Grey and Ripon*, it is perhaps as well that means should be provided to work the condensers by injection in case of need.

The economic value of superheating the steam is perhaps not so generally acknowledged, and certainly the number of patents that were taken out a few years ago, and the number of failures that occurred, were enough to confuse not only steamship owners, but even engineers. Many cases of failure no doubt occurred through faulty designs, others through not sufficiently perfecting designs which, though good in themselves, did more harm than good through the omission of some simple precautions. The main cause of failure, however, was doubtless the excessive amount of superheating that was originally practiced. Thus, in the case of the old *Vesta*, that ran on the river Thames about five and twenty years ago, the engineer set the sponson beams on fire when he blew off the steam! Of late years, excepting in America, nothing so excessive has been used; still, in the earlier revival of the principle, the steam became so hot that it was not at all unusual for the packing to be burnt. Now, however, it seems to be acknowledged that the principal use of superheaters in steam-boilers is to thoroughly dry the steam before it enters the steam-pipes, and perhaps to import a sufficiently extra amount of heat (say, from 300° to 350° Fahrenheit), to prevent condensation while it is being expanded in the cylinder.

The engines of the *Earl de Grey and Ripon* (for engraving of which see Plate 315) appear to be a very favourable specimen of the present state of marine engineering.

They are of the double piston-rod horizontal class; each engine being furnished with its own surface condenser, air and circulating pumps. The surface in each cendenser is 485 sq. ft., or 14·9 sq. ft. per nominal horse-power. Diameter of air pump 8in., and of circulating pump 6in.; both are double-acting and worked direct from the piston, as are also the feed and bilge pumps. Injection cocks are fitted to the condenser of sufficient size, so that in case of any accident happening to either sets of condense pipes, the common system of condensing may be adopted.

The circulating water passes through the tubes, the steam being outside. The tubes are ¾in. diameter outside, and the length 4ft. 6in. Each tube is provided with a screw gland and stuffing-box at either end, to allow for the unequal expansion and contraction constantly taking place. The boiler is fitted with a superheater, and the steam is expanded in the cylinders by means of extra cut-off slide valves.

It will be seen that the consumption of coal is only about 2½lbs. per indicated horse-power per hour, a result seldom equalled even in much more complicated engines

A donkey engine is fitted in the vessel capable of pumping from all or any of the ship's compartments—the sea—or the hot well and of delivering overboard—on deck—or into the boiler.

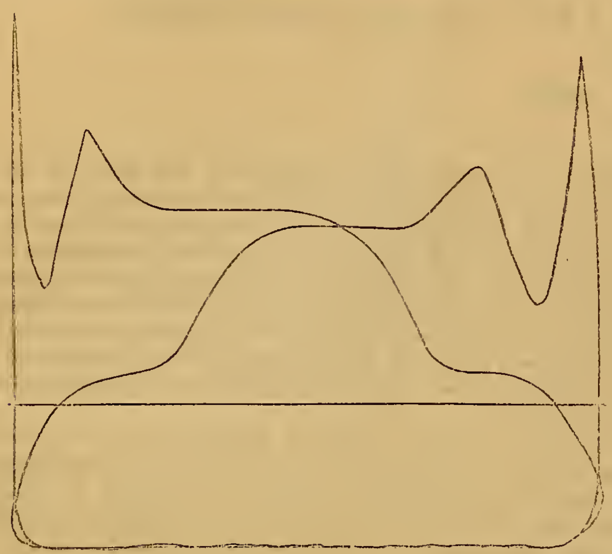
The screw-propeller is fitted with three loose blades, which allow of the pitch being altered to any amount desired between 13ft. 6in. and 15ft 6in. The blades are of the ordinary kind, with the leading edge cut off.

These are about the first marine engines built by the Thames Iron Works Company, they having been almost exclusively employed in building some of the largest ironclads for the English Government. Among these may be mentioned the *Warrior*, the first of the ironclad fleet, 6,176 tons B.M. The *Minotaur*, 6,620 tons, B.M., the *Valiant*, 4,062 tons, B.M., and several smaller vessels. Also for foreign Governments as the Russian battery, *Pervenetz*, with 4½in. armour plates fixed on the sloping sides of the vessel. The *Sultan Mahmood* 4,221 tons, B.M., with 5¼in. armour plates. The *Victoria* Spanish frigate 4,862 tons, B.M., with 5½in. armour plates at present confined to the Victoria Docks. The Prussian frigate *Wilhelm* I., 5,938 tons, with 8in. armour plates, and the *Serapis* steam transport for the India Transport Board, a beautiful vessel of 4,173 tons B.M., with accommodation for 1,450 persons.

The indicator diagrams on next page were taken during the trial trip from the forward engine, the card from the after engine was so exactly alike that it may be taken as the same. Steam pressure 19lbs., vacuum 14lbs., revolution 82., indicated horse-power 166·3, or 332·6 for both engines.

The following are the principal dimensions, &c.:—Length on deck 150ft., breadth of beam, 21ft. 6in.; depth of hold at ditto, 12ft.; depth of hold to spar deck, 12ft.; length of engine space, 34ft. 4in.; tonnage O.M., 335$\frac{31}{94}$; kind of engines, horizontal, double piston-rod; kind of boilers, ordinary tubular; diameter of cylinders, 29in.; length of stroke, 2ft.;

diameter of screw, 9ft.; length of screw, 1ft. 10in.; pitch of screw, 14ft. 6in., variable from 13ft. 6in. to 15ft. 6in.; number of blades of screw, 3; number of boilers, 1; length of ditto, 7ft. 10in.; breadth of ditto, 12ft.;



Steam, 19lbs.; vacuum, 14lbs.; revolutions, 82.

height of ditto, exclusive of steam chests, 12ft.; cubic feet in steam chests, 270; number of furnaces, 3; breadth of ditto, 3ft. 3in.; length of fire-bars, 6ft. 2in.; number of tubes, 432; internal diameter of ditto, $2\frac{3}{16}$in. full; length of ditto, 4ft. 6in.; diameter of chimney, 2ft. 10in.; height of ditto, 25ft. 6in.; area of immersed section at load draft, 170 sq. ft.; load on safety valve, 22lbs. per sq. in.; heating surface, 1500 sq. ft.; contents of bunkers, 67 tons; consumption of coals per hour, $7\frac{1}{2}$cwt.; date of trial, July 10th, 1866; draft forward, 5ft. 5in.; draft aft, 9ft. $7\frac{1}{2}$in.; average revolutions, 80; speed in knots with tide, 11·9; ditto against, 8·53, mean 10·2 knots; weight of engines, 27 tons 3cwt. 3qrs. 24lbs.; span gear, 3 tons 8cwt.; weight of boilers, with water, 30 tons 13cwt. 3qrs. 20lbs. Frames: shape ⅂L, 3in. by 3in., $\frac{5}{8}$in. and 14in. apart; number of strake of plates from keel to gunwale, 8; thickness of plates, $\frac{1}{2}$in.; number of bulkheads, 5; diameter of rivets, $\frac{5}{8}$in.; distances apart, $2\frac{1}{2}$in. and 3in.; double rivetted; depth of keel, 6in.; dimensions of ditto, $2\frac{1}{2}$in.; independent steam, fire, and bilge pumps; two masts, schooner rigged; intended service, Ordnance Department.

SAFETY FISHING BOATS.

We have at various times drawn the attention of our readers to that excellent Society, the Royal National Lifeboat Institution, to whose strenuous and persevering exertions our seafaring population is indebted for the preservation of hundreds and thousands of lives. Most of the latter have been, and are continually rescued from, vessels of larger size shipwrecked on our coasts, yet a considerable portion of them are reclaimed from vessels of much smaller proportions, and chiefly fisherboats, the loss of which might be avoided in many cases by a more perfect and rational construction of these boats. Prevention is better than cure, and the Committee of the Lifeboat Institution, instead of confining themselves to merely affording assistance to the shipwrecked, have resolved upon giving the sufferers a practical lesson, by teaching them how to prevent those casualties. We think this is decidedly a step in the right direction, and which will doubtless meet with the full approval, and, let us hope, co-operation of all those in any way interested in the work of the Society.

It was proposed to increase the safety of the larger class of open and half-decked fishing-boats by enabling them to be made temporarily insubmergible, in the event of their being overtaken by gales of wind, when at long distances from the land.

No doubt was entertained by practical persons on the coast of the need of such improvement, and of the feasibility of the plan proposed to effect it; but the coast boatmen being an inert class, not readily departing from what they have been accustomed to, it was not thought likely that they would themselves initiate any such changes, however needed.

The committee, therefore, decided to build a few pattern boats, and to place them at some of the principal fishing stations, in the hands of experienced and trustworthy boatmen, to whom they would be lent or let at a small percentage on their earnings, for a period of twelve months; at the end of which time they might be sold, and would remain in the several localities where placed, as samples from which the other local boats might be improved in a similar manner.

In the event of the experiment proving successful, it was believed that a great boon would thus be conferred on the fishermen and other boatmen of certain classes on the coast, as not only would numberless lives and boats be saved that in course of time would otherwise be lost, but that the boats would often be able to remain at sea, and safely continue their fishing in threatening weather, instead of returning to the shore at great pecuniary loss to their crews, as is now too frequently the case.

Five of such boats were accordingly ordered—three to be built in Scotland, one at Yarmouth, and one by the builders to the Institution in London, upon designs supplied by Mr. Joseph Prowse, of H.M. Dockyard, Woolwich. Two of the boats built in Scotland, one at Peterhead, and the other at Anstruther, have been tested and are now at work, having already afforded the utmost satisfaction to their crews. Captain A. Sim, hon. sec. of the Lossiemouth branch of the Institution, writing from that place on the 18th March, states:—"The safety fishing boat sailed from Granton Harbour on Wednesday, the 13th inst., at six a.m., and was here the following day at five p.m., after lying to for some time off Peterhead, thus making the voyage in thirty-six hours—no bad test of her sailing qualities. She has been very much admired here by all the fishermen; in fact, the seafaring population are unanimous in their opinion, that she is just the thing for this coast, and I trust she may be the beginning of a new era in decked boats."

The interior fittings of the boats have been so arranged as not to interfere with their every-day work, yet so as to enable them to be quickly made insubmergible.

The arrangements by which this object is attained are shown in the annexed diagrams, drawn to a scale of $\frac{1}{10}$in. to 1ft. The following are the leading features of this combination:—

1st. The fore cabin forms a water-tight compartment, the access to it being by a water-tight hatch in the deck, instead of an open door at the side.

2nd. The usual compartment at the stern is also made water-tight.

3rd. A side deck runs along either side, as in barges and in some of the smaller class of yachts, called *well boats;* thus leaving a large open main hatchway, of sufficient size for conveniently working the nets, yet which, by the aid of coamings and hatches, and a water-tight tarpaulin, stowed away in the hold or fore-cabin in fine weather, could, in a few minutes, on the occurrence of bad weather, be securely covered over, so that no water could get access to the hold on a heavy sea breaking over the boat. The inspection of a common coasting-barge with her hatches on and covered over, will convey an exact idea of the simple manner in which the above arrangements are carried out.

Fig. 1 is a longitudinal section, Fig. 2 a deck plan, and Fig. 3 a body plan of a safety fishing-boat. The dotted lines of Fig. 1 show the position of the compartments, bulkheads, masts, pumps, thwarts, and shifting flat or deck; *a*, scuttle in boat's side above the side decks; *b*, scupper in the boat's side above the stern deck; *c*, screw plug to drain the stern compartment.

In Fig. 2, A are the open hatchways of the main hold, to be covered with portable hatches, and a water-tight tarpaulin cover in gales of wind; B, shifting coamings for the hatches; C, side-deck; D, forecastle deck; and E, stern deck.

Fig. 3 shows the exterior form of transverse sections at different distances from stem to stern.

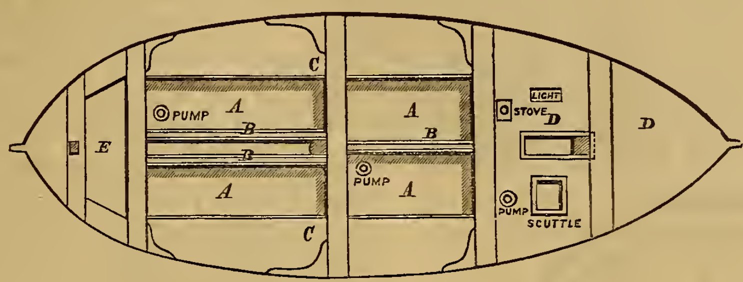
In the midship section, Fig. 4, F represents the thwart, C the side deck, B the shifting coaming over the fore hold, I the shifting deck or flat, and H, the hatches in place.

The same letters of reference denote the same parts in the other sections, Figs. 5 to 8; Fig. 6 shows, moreover, the crutch for receiving the mast, and Fig. 5 the mast.

The size of these boats, viz., length, 40ft., width 14ft., depth amidships 7ft., has been selected as the most convenient size for use both in line and net fishing. A sixth boat, however, 45ft. long by 15ft. wide, is about to

be built for Anstruther, where the fishing-boats go as far as 100 miles from the land to fish, and have lines on board of the total length of 23,500yds., or nearly 13½ miles, which require a large space to stow them away all coiled in baskets, besides a cargo of fish.

FIG. 2.

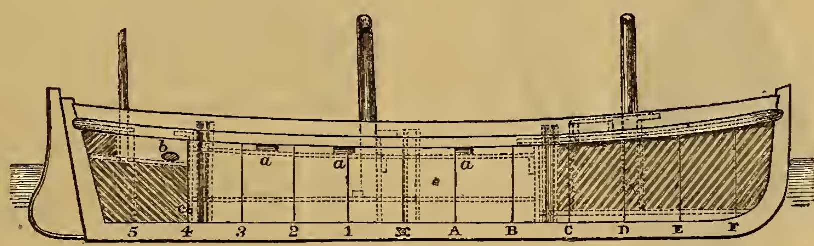


DECK PLAN.

FIG. 5.

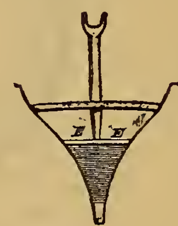
CROSS SECTION AT D.

FIG. 1.



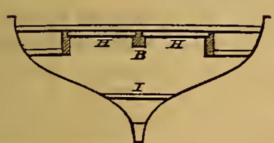
LONGITUDINAL SECTION.

FIG. 6.



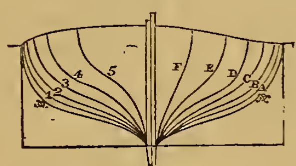
SECTION AT 5.

FIG. 7.



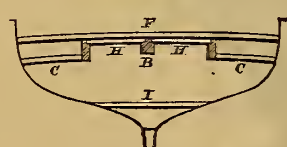
CROSS SECTION AT B.

FIG. 3.



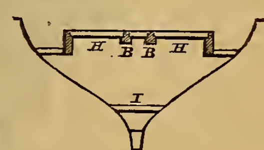
BODY PLAN.

FIG. 4.



MIDSHIP SECTION.

FIG. 8.



CROSS SECTION AT 3.

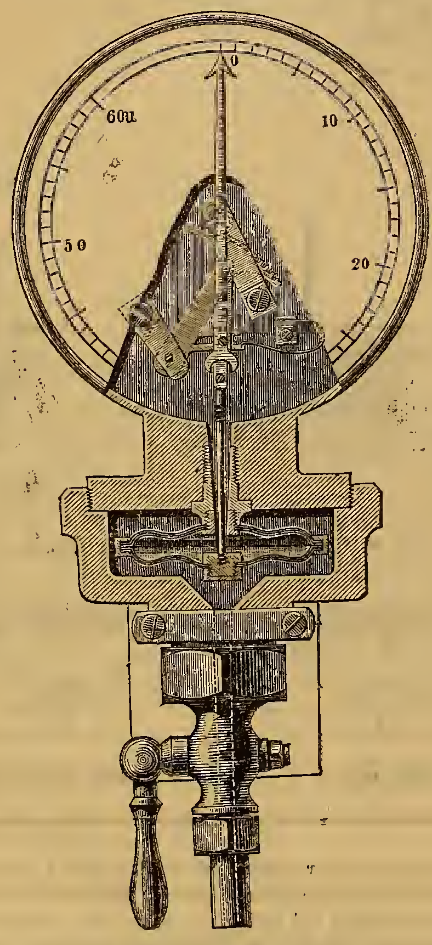
THE ANCILLARY LINK OF THE TRANSATLANTIC CABLE.

Mr. Cyrus W. Field has completed a contract with the Telegraph Construction and Maintenance Company, for the manufacture of a cable to be laid between Placentia (Newfoundland) and Cape Breton. This additional link will, in time of peace, insure the safety of communication between the continents of Europe and America, and obviate the difficulties recently felt by the failure of American land lines. The manufacture of the new cable was begun on April 4th, under the direction of Sir Samuel Canning, Mr. Henry Clifford, and Mr. Willoughby Smith. The cable will consist of a core of seven copper wires (No. 18 guage), weighing 400lbs. per nautical mile. The wires, precisely similar to those of the Atlantic cable laid last year, will be twisted in a strand, over which will be placed four coatings of gutta-percha, alternating with what is known as Chatterton's compound, this again being served with jute yarn. The exterior of the new rope will be, however, somewhat different from that of those previously submerged. The Atlantic cables were covered with ten No. 13 galvanised wires, each wire being coated with five yards of Manilla hemp laid on in a spiral and saturated with a preservative compound. The new cable will have twelve No. 9 larger galvanised wires laid over, all in contact with each other, in a quick spiral. The cable will be about one-third less in size than the Atlantic lines, but will be nevertheless heavier, owing to the additional large exterior wires, and will weigh 44½ cwt. per nautical mile against 36 cwt., the weight of the Atlantic cable for a corresponding distance. The shore end will be also smaller, and this portion will weigh 10 tons per cwt. Altogether the new link will measure 321 nautical, or about 360 statute miles in length. One of the shore ends will rest at Placentia, which is about 63 statute miles from Heart's Content, to which it is united by a good road, along which telegraph land lines will be placed, and the course of the cable will be first to St. Pierre, a French fishing station, and then to Sidney, Cape Breton. The extreme depth of water on the route is 252 fathoms, or about a tenth of the greatest depth in which the Atlantic cables are submerged. The bottom is good, and there is scarcely any doubt that the laying will be perfectly successful. It may be observed that a break is made at St. Pierre, because if the French Government should, as is anticipated, lay a line across the Atlantic, this little island would probably be the point to which the western end would be taken, and the cable now in course of construction would, in that case, serve to carry on to the American continent the messages sent by the route established by the French. It is expected that the new cable will be completed about June, when a steamer will take it out to Placentia, and the promoters of the project are confident that it will be in working orde on or even before the 1st of August.

DEWIT'S PRESSURE GAUGES.

Since the patents for Bourdon's gauges became void in France and England, many makers have been working his invention with more or less success, some confining themselves to slavishly copying the original designs, others modifying the latter by either improving or impairing them. Amongst those whose modifications contain improved features, though in the main their plan does not differ from Bourdon's, we may name Messrs. W. C. and K. Dewit, of Amsterdam. The increased size of the dials and particular mode of fixing the glasses, they are hardly entitled to claim as now; but, on the other hand, by fixing the interior mechanism of the apparatus on an independent plate, they certainly realise a greater degree of rigidity, and render their instruments more serviceable for stationary boilers or engines.

Another description of Dewit's gauges is similar to Schäffer and Budenberg's manometer, of which we gave an illustration in a provious issue.*



Instead of the corrugated argentine plate, as used in the latter, the Dewit gauge contains in a circular case two diaphragms made of steel, hardened and tempered, and coated with thin brass sheets to prevent oxidation. These diaghragms are clampod together at their outer edges, and left free to move. They are *buckled*, instead of being corrugated concentrically, and are stated to be more durable and less affected by the percussive shocks of water than corrugated-plate or Bourdon gauges. Our illustration shows a partial section of one of Dewit's double-diaphragm gauges; for minor purposes the "single-diaphragm gauge," constructed on the same principles, but without the upper buckled steel-plate, is thought to answer equally well.

ON RECENT SOUNDINGS IN THE GULF STREAM.

Abstract of a paper read before the National Academy of Sciences by HENRY MITCHELL, Assistant U.S. Coast Survey.

(*From the American Journal of Science and Arts.*)

Early in the spring of last year an application was made to the Coast Survey by the International Ocean Telegraph Company for information relative to the form and character of the bottom of the Straits of Florida between Key West and Havana along the proposed track of the submarine telegraph cable which is to connect the United States with the West India Islands. It was clearly the province of the Coast Survey to supply information of this sort, and a special survey was therefore ordered under instructions from Mr. J. E. Hilgard who, during the illness of Prof. Bache, conducts the work of this bureau. These instructions were carried out carefully and under favouring circumstances, so that the results are entitled to confidence.

The distance from Sand Key, on the extreme southern point of the Florida reef to El Moro rock at the entrance to Havana, is but a trifle over 82 miles. To lay a cable over this short distance would seem to be an easy task and one that should long since have been executed. In fact, however, the locality offers a new problem to the engineer, viz.: to lay a cable nearly at right angles to a strong stream, or system of streams, flowing through a rocky pass of great depth. The new survey, if it does not, as is hoped, supply the elements for the solution of this problem, at least developes and guages the difficulties of the task, and incidentally adds a few items of interest to physical inquiry.

The line of maximum depression was struck at a point 24 miles north of the Moro, and followed some distance to the north-east with depths of 853, 845, and 794 fathoms. The direction of this line does not correspond to that of the Gulf stream in this neighbourhood; but a glance at the map will show that a S.W. course would be a natural one for the Polar current, as it is called, which runs near the bottom.

The numerous soundings of this survey make it possible to develope a profile of section from Sand Key to the Moro, and the subjoined table gives the numerical data for such a profile.

Section of Soundings across the Straits of Florida, from Sand Key to El Moro.

	Points on profile.	Distances from Sand Key.	Distances from El Moro.	Depths. By Indicator.	Depths. By outrun of line.	No. of stations used.	Kind of bottom.	Remarks.
Northern approach to channel.	A	$2\frac{3}{4}$	$79\frac{1}{2}$		65		rock.	Coral strewn over with shells.
	B	$7\frac{1}{2}$ to $8\frac{1}{2}$	$74\frac{1}{2}$	111	125	5	„	Specimen of coral debris obtained.
	C	11	$71\frac{1}{4}$	129	132	1	„	
	D	$14\frac{1}{2}$	$67\frac{3}{4}$	289	309	2	„	Specimen of coral debris.
	E	$18\frac{1}{4}$	64	369	397	1	mud.	Specimen of gray mud.
	F	$24\frac{1}{4}$	58	432	466	1	„	Specimen of mud nearly white.
	G	$29\frac{1}{8}$	$53\frac{1}{8}$	504	553	2	„	Specimen nearly white with dashes of red.
	H	34	$48\frac{1}{4}$	687	No indication of depth by the outrun of the line.	1	„	Specimen of stiff mud, nearly white.
	I	38	$44\frac{1}{4}$	794		1	„	Specimen gray and granular mud.
Southern approach to channel.	i	$45\frac{1}{2}$	$36\frac{3}{4}$	845		1	„	Specimen nearly white with red tinge.
	h	$51\frac{1}{4}$	31	842		3	„	Specimen same as above.
	g	$55\frac{3}{4}$	$26\frac{1}{2}$	813		2	„	Specimen same as above.
	f	60	$22\frac{1}{4}$	455		2	„	Specimen of mud with drab colour.
	e	$61\frac{1}{2}$	$20\frac{3}{4}$	380		1	„	No specimen, some doubt of cast.
	d	$67\frac{1}{4}$	15	710		1	hard.	
	c	$73\frac{1}{4}$	9	748		1	mud.	
	b	$78\frac{1}{2}$	$3\frac{3}{4}$	583	620	1	sand.	Sand or mud of reddish brown hue.
	a	$80\frac{1}{2}$	$1\frac{3}{4}$	243	244	1	rock.	A small shell obtained.

In this profile, which is, strictly speaking, that of a diagonal section, the point of maximum depression is found 37 miles from the Moro, and is 843 fathoms. The approaches to the great valley from the two coasts are dissimilar in general features. From the northward the bottom falls away in terraces whose interveuing slopes are nowhere abrupt; while from the southward an irregular and hilly approach is found with indications of abrupt, if not precipitous changes of elevation. Above the terraces of the north shore the sea lies almost motionless, while among the canons of the southern half of the Straits flow the Gulf Stream and its counter currents.

* See ARTIZAN of February 1, 1865, page 33.

These natural distinctions authorise us in taking up separately the descriptions of these approaches, and we shall proceed to do so briefly, commencing at Sand Key and following the profile southward from A to I; then commencing at the Moro and following northward from *a* to *i* (see table).

Northern Approach.—Leaving Sand Key, the water deepens rapidly to 13 fathoms, then shoals again to 7 fathoms upon a coast bar or ridge parallel to the reef, and scarcely ⅜ths of a mile distant from it. Seen from the deck of a ship upon a fine day, this bar is marked by a narrow belt of pale blue green water in beautiful contrast with the dark black of the ocean. The bottom can be seen on crossing it and appears to be a pure white rock *in situ*, strewn sparsely over with fragments of the weathered and brown reef rock. Two miles farther out carries us to the point A, where our table for the profile commences with 65 fathoms of water on a slope of 1ft. in 37ft. The next points B and C lie upon a nearly level plain which terminates about twelve miles from the reef in a slope of 1ft. to 22ft. Upon this terrace numerous soundings were made covering about 8 miles of longitude, which show that the formation belongs to the reef system and lies parallel to it. Chips of white coral rock were brought up in one of the casts—in all of them the hard bottom was felt by the hand. At what appears to be the foot of the foreslope of this terrace (point E) the bottom is found to be soft mud, and a specimen procured proved to be of a grey colour quite in contrast both as regards colour and consistency, with that obtained above or beyond. It differed from the white muds beyond, of which we shall hereafter speak, in possessing a granular character and retaining the same when dry. It is conceived that this terrace was once a dry reef covered over like Sand Key with dark fragments of agglomerated reef rock, and that a subsequent submergence has caused all this loose and weathered material to be swept down to the foot of the fore slope.

Between D and E, in about 300 fathoms, the swept portion of the Florida Reef, if not also the base of the formation, is passed. At F, G and H the bottom is of nearly white mud, with dashes of red at the last named point. These muds were found to set on drying. The mud with dashes of red is supposed to be the debris of a kind of coral, quite common upon the reef, which is spotted as if with drops of blood. These three stations seem to comprise another grand terrace, because at the 500 fathoms curve there seems to be a considerable belt where a difference of a mile in latitude or longitude scarcely altered the soundings. If this is so, we must suppose that we are not yet beyond the reef and that the rock still underlies the material which the specimen cup procures. At the foot of the fore slope of this second terrace (I) in 794 fathoms, the mud is again grey and granular, while the next station beyond is of the ordinary white tinged with red.

Do these features belong to the history of the Gulf Stream or to the geology of the coral reef? As these slopes and terraces are now scarcely traversed by the streams, we are inclined to regard them as exhibiting the order in which, through successive ages, the reef has alternately subsided and stood still. As far as the swept portion of the reef apron extends, we see no indications of any caving down of the structure; and in the neighbourhood of the second terrace the presence of mud forbids the supposition of long continued abrasion.

Southern Approach.—The Moro Rock is nearly perpendicular at the water line, but retreats at points higher up. Its northwest profile is convex with a mean dip of 45° from the castle wall to the sea. Leaving this rock and advancing 1¾ miles northward, the bottom declines 1ft. in 7ft. to point *a*, where the depth is 243 fathoms and the bottom, rock. From *a* to *b* the depth increases very rapidly, 1ft. in 6ft. and the foot of the Moro Rock is passed. The bottom at *b* is a reddish brown mud which becomes in part granular on drying—in many respects it resembles the specimens from the foot of the fore slope of the coral terrace on the north bank of the straits. It is no doubt weathered debris swept down from the Moro.

The dip of the rocky part of this space between *a* and *b* is unquestionably much more precipitous than the mean we have stated, because 1ft. in 6ft. is altogether too great an inclination for the material found at *b*.

Beyond *b* the slope is gradual, 1ft. in 32ft., and terminates at *c* in the nearly horizontal bed of a depression which we shall call the Moro Channel. Here at *c* the depth is 748 fathoms. Six miles farther carries us across the Moro Channel and we find the depth a trifle more shallow, 710 fathoms, at *d*.

At *e* and *f* we find ourselves near the summit of a submarine mountain whose height above the bed of the Straits is about 2,400ft. This mountain, lying but a few miles to the northward of the axis of the Gulf Stream, may be claimed as a point of decided interest in this survey. It is scarcely 21 miles from the shore of Cuba, whose hills are in full view if the weather is fine. Six casts were made upon its summit under the greatest difficulties, owing to the current. Only three of these proved successful and but one yielded a specimen of bottom. The depth on the summit was found to be about 400 fathoms. On looking over the work of former years we find that Capt. B. F. Sand in 1858 made deep-sea soundings in this locality, and that he struck one sounding of 320 fathoms on the same parallel, but some twelve miles to the westward. He procured a specimen and observed the temperature to be 60° which is the usual amount for this depth in the Straits of Florida. The Polar current which underlies the stream, following the line of maximum depression, has a temperature of less than 45°. At first thought, it might be supposed that an obstacle in the track of the stream would cause an ascension of the Polar current, but when we consider that this Stream Bank has not the nature of a bar, and that the deep channel way beyond is ample, there would seem to be no reason for an ascension of the cold waters in this neighbourhood.

Several other casts, not referred to in our table, because too far to the eastward of the section line, furnish some clue as to the form of the Stream Bank. It appears to be triangular in its general figure, presenting at its west angle a bold prow to the stream. As the current is here flowing with an accelerating velocity, a deposit is impossible. This bank, it appears to us, must have, like the adjacent reef, a firm constitution. It is an interesting question whether it belongs to the mountain system of Cuba (as its line of least water running E. and S.E. might seem to indicate), or whether it is an ancient reef now wearing and crumbling away. The least depth is about that of the foot of the swept portion of the reef apron on the north side of the Straits—it may indicate the true depth of the Gulf Stream itself, and, if so, its summit is not now abraded, while its base must be wearing away under the action of the Polar current. A bank so situated must have precipitous slopes.

Observations upon the trend of the lead line, on hauling in, furnish indications that the thickness of the upper moving stratum, *i.e.*, the depth of the Gulf Stream, is scarcely more than one-third of the maximum depth of the channel. This stream seems to be an overflowing of water, not a profound movement. In the exchange between the Gulf of Mexico and the Atlantic, the office of the Gulf Stream appears to be the restoration of surface level, while the office of the counter stream ("Polar current") below, is the restoration of equilibrium thus disturbed, between waters of different specific weights or densities. To illustrate this view of compensating currents, we may be suffered to recall an instance from our experience in observations at the mouth of the Hudson River. In the dry season (July) the surface outflow (brackish) through the narrows of New York Harbour occupies nine out of the twelve tidal hours, while in the lowest water stratum the case is more than reversed, the inflow (salt) predominates to that extent that, as a general thing, it is continual along the bottom, although not constant in velocity. The same conditions, with variable proportions, were followed some distance up the river. On running a line of levels from New York city to Albany, it was found that the bed of the Hudson lies below the mean level of the sea for over a hundred miles; but that the surface of the fresh water, even in the dry season, is above this level—not so much above, however, as to equalise the difference of specific weight between it and the sea water, so that the latter, during the summer months, flows in along the bed of the stream, while the former overflows into the ocean.

In the recent survey observations upon surface densities were carried over several hundred miles. These show decided contrasts between the ocean and the stream, but no greater than the differences of temperature might lead us to expect.

The Gulf Stream is essentially confined to the southern half of the Strait in the portion crossed by this survey, but no westwardly drift along the north shore was observed except at one time a feeble flood tidal current setting close along the reef. It is not impossible that the widths of the Gulf Stream vary, as its velocities are known to do, and both of these may in many cases depend upon long-continued gales of wind. During the period of the recent survey, however, the weather was exceedingly calm in the Gulf, and, as far as learned, generally quiet at sea; yet the velocities of the stream altered in a marked manner, and so much so that the changes became a matter of comment among pilots and shipmasters arriving at Havana. It would be exceedingly interesting and practically useful to ascertain from systematic inquiry the order of these variations. We would suggest, as a reasonable hypothesis, that these variations follow those changes of mean sea-level which depend upon the declinations of the sun and moon—more especially the latter. There are no two seas upon the earth whose tidal phenomena differ more essentially than those of the Gulf of Mexico and the Atlantic Ocean; and it is a matter of certainty that the elevations of these two bodies of water are not effected in the same manner and degree by the half-monthly changes of the moon's declination. Professor Bache's paper "On the Tides of Key West," published in the "Coast Survey Report" of 1853, shows that the mean level of this station is one foot higher when the moon is in the equator than when she is at her greatest declination. In the North Atlantic the order is the reverse of this; the mean level is there about three inches higher at the maximum than at the zero declination.* Small as these

* From computations of the Coast Survey, and from Phil. Trans. R. S., 1839.

relative changes of elevation may seem, they must bear a large proportion to the total head of the Gulf Stream which suffers exceedingly little resistance in its course.

INSTITUTION OF CIVIL ENGINEERS.

A MEMOIR ON THE RIVER TYNE.

By Mr. W. A. Brooks, M. Inst. C.E.

This paper contained a description of the tidal phenomena of the river, in its condition previous to being placed, in 1842, under the charge of the author for its improvement, as contrasted with the phenomena which were found to exist after the completion of the river works. These works consisted, mainly, in the first instance, of timber jetties, subsequently connected by river walls, formed of rubble mixed with ships' ballast, which was brought into the harbour and discharged into the line of the river works, affording an example of how much good might be effected in a port by the judicious application of available materials. The whole of the works, on both sides of a navigation of 10 miles in length, forming what were locally called the Tyne Improvement Works, were executed out of a revenue applicable to them, not amounting to more than £5,000 a year, or to £80,000 spread over a period of about 16 years. Northumberland Dock, inclosing a reclamation from the river of above 70 acres, and the Tyne Piers, had been, or were being executed, out of separate funds.

Much of the interest of the paper consisted of a dissertation upon the cause of the formation of Bars at the mouths of rivers, and the means available for their amelioration, according to the well-known theory of the author, that "Bars owe their existence to the confliction which takes place between the current of the early flood tide and that of the ebb, where shoals exist, preventing the free drainage of the backwater during the proper period of the discharge of the ebb."

The remainder of the paper was devoted to the consideration of the effects which various forms, or alterations in the direction, of the piers at the mouth of the Tyne would have produced, as contrasted with the result of the piers planned by the author, which were already carried out to a considerable length.

At the monthly ballot the following candidates were balloted for and duly elected:—As Members—Mr. Charles Napier Bell, Westminster; Mr. John Frederick Bourne, Inspector General of Railways and Colonial Railway Engineer for the Cape of Good Hope; Mr. John Edward Boyd, Engineer-in-Chief of the European and North American Railway; Mr. William Dennis, Westminster; Mr. John Marley, Mining Offices, Darlington; Mr. William Martley, Locomotive Superintendent of the London, Chatham, and Dover Railway; Mr. Thomas Robert Shervinton, District Engineer, East Indian Railway. As Associates—Mr. Thomas Charles Clarke, Assistant Borough Engineer, Portsmouth; Mr. William Donaldson, M.A., Westminster; Mr. William Hartree, Greenwich; Mr. Henry George Hulbert, Bath; Mr. Thomas Jackson, jun., Eltham; Mr. Edward Davis Mathews, Resident Engineer, Quebrada Mining Co., Túcacas, Venezuela; Mr. Henry Beadon Rotton, late in the service of the Government of New Zealand; Mr. Peter Thomson, Liverpool; Mr. Thomas Andrew Walker, Westminster; and Mr. John William Watson, Contractors' Staff, Ceylon Railway.

THE SUEZ CANAL.

By Colonel Sir W. Denison, K.C.B., R.E., Assoc. Inst. C.E.

It was stated that the scheme of the Suez Canal might be said to comprise two distinct undertakings. The first, and principal, was the construction and maintenance of a broad and deep water channel on one level, between Port Said on the Mediterranean, and Suez on the Red Sea. The second, preliminary in point of time, and, indeed, essential to the construction, as well as to the beneficial use of the canal, was the maintenance of a supply of fresh water sufficient for the wants of the population congregated along the line of canal, and specially at its two extremities. The arrangements for the last-named undertaking had been completed and were described. At Suez, a dry dock, capable of taking in the largest steamer, and an outer port, or basin, were in progress, but these are being carried out by a separate agency.

An account was then given of the character of the works of the salt-water canal, the course of which was traced, and of the state of the works when visited by the author, including the jetty, or breakwater, at Port Said, to protect that port against the action of the north-westerly or prevailing winds.

The opinion arrived at by the author, based upon what he saw and heard during a visit to the canal, and upon a consideration of the correspondence between M. de Lesseps and the late Mr. R. Stephenson, and of the report of Mr. Hawkshaw, dated February, 1863, was:—First, that (subject, of course, to the condition that the relative levels of the Red Sea and the Mediterranean were as stated by the French authorities) there would be no extraordinary difficulty in carrying an open salt-water channel from the Mediterranean to the Red Sea of the depth proposed, namely, eight metres. Secondly, that no special difficulty in maintaining this channel need be anticipated. Thirdly, that it would be necessary to modify the section proposed by the French engineers, making the side slopes much more gradual. And, fourthly, that the cost of maintaining the above-mentioned depth of water would be found at first to be largely in excess of the amount estimated. Eventually, it was by no means impossible that means might be found to fix or check the drift of sand, or to shut it out from the canal. But for some years it must be expected that the ordinary action of the atmosphere, which had filled up former excavations made in this dry desert, would have the same effect in the new canal. Looking at the work as an engineer, there did not appear to be any difficulty which a skilful application of capital might not overcome.

It was specially resolved that, in order to insure a fuller attendance than would probably be obtained on Easter Tuesday, the meeting should be adjourned until Tuesday evening, April 30th, when it was announced that the discussion upon Sir W. Denison's paper on "The Suez Canal" would be resumed, and, time permitting, the following paper would be read, "On Optical Apparatus used in Lighthouses," by Mr. J. T. Chance, M.A.

PHILOSOPHICAL SOCIETY OF GLASGOW.

A numerously attended meeting of this society was held on Wednesday, the 3rd ult., in Anderson's University Buildings, Professor Grant in the chair, when a most interesting and able lecture, illustrated by experiments and various diagrams, was given by Mr. A. S. Herschel "On the Heights and other Particulars of the Late November Meteors." Mr. John Mayer afterwards made some remarks on the manufacture, properties, and uses of nitro-glycerine, or blasting oil, the new explosive material, giving some experimental illustrations.

CHEMICAL SOCIETY.

TITRATION OF THE COMPOUND ETHERS.

By J. A. Wanklyn, Professor of Chemistry at the London Institution.

A close agreement between the results of an elementary analysis and the theoretical percentages of carbon and hydrogen required by a compound is often but a poor guarantee of the purity of that compound.

Pure acetic ether and acetic ether mixed with as much as 10 per cent. of common alcohol, would give very nearly the same results on combustion. For 10 per cent. of alcohol the difference in percentage is 0·23 of carbon, and 0·4 of hydrogen.

There is a similar difficulty in detecting amylic alcohol in acetate of amyl by means of a combustion. Pure acetate of amyl, and acetate of amyl contaminated with 10 per cent. of amylic alcohol, differ in percentage by only 0·37 in the carbon, and 0·28 in the hydrogen. Indeed, it seems that this very case has actually occurred in practice. The boiling point of acetate of amyl used to be given at 133° C. In reality, the true boiling-point of the pure acetate is 140° C. —a result which has been recently confirmed by other experimenters, both in this country and in France.

Having had occasion to prepare a number of the compound ethers in a high state of purity, I have employed a titration as the test of purity, and have found it to be both rapid and easy of execution, and precise in its results. Berthelot has also, as is well known, employed a titration-method in some of his researches on the ethers.

The method of proceeding which I have employed is very simple. I take an alcoholic solution of caustic potash, and having determined the strength of it by means of standard acid, digest the ether, which I wish to titrate, with a given volume of this solution of potash. When the ether has been decomposed by the potash, I determine the residual potash still unused by the ether. The difference between the potash originally caustic in the volume of solution, and the potash found caustic after digestion with the ether, is the quantity of potash neutralised by the ether.

The strength of the standard sulphuric acid which I use is about 4 per cent., and the alcoholic solution of potash about 6 per cent. I believe, however, that a higher degree of accuracy would be attainable by having the solution still stronger.

The standard sulphuric acid was made by diluting pure sulphuric acid with water, and afterwards determining the strength of the dilute acid by precipitation with chloride of barium. The standard acid was also verified with pure carbonate of soda, and with oxalic acid. A burette which had been carefully calibrated was used far measuring out the standard acid.

The alcoholic solution of potash was prepared by dissolving potash in pure alcohol of about 85 per cent. Experiments showed that neither a fortnight's keeping in a stoppered bottle, nor a short digestion at 100° C., altered its strength. The quantity of alcoholic solution of potash taken for a titration was measured in a small flask with a very narrow neck, on which a mark had been made with a file. The temperature of the potash-solution was observed. The capacity of the measuring flask up to the file mark was about 50 cubic centimetres.

The digestion of the weighed quantity of ether with the alcoholic potash is managed in a flask with a long neck. In general, the compound ethers decompose with great ease and rapidity; if necessary, they might be sealed up in a digestion-tube and heated in the water-bath. All the examples about to be given are examples in which the digestion was managed without the employment of sealed tubes. The complete disappearance of the smell of the compound ether is, in many cases, a good criterion of the termination of the decomposition by the potash.

In titrating the solutions with the standard acid, a peculiar method of reading the point of neutrality was followed.

When sulphuric acid is added gradually to an alkaline solution, the following changes in the action on litmus paper are observable:—At first the colour with litmus is blue. By-and-by the blue colour fades, and then, on adding another drop of dilute sulphuric acid, the colour is distinctly red. Now, in reading off the quantity of standard sulphuric acid necessary for saturation, several plans may be taken. The utmost point at which litmus paper remains distinctly blue may be read, and the earliest point at which a distinct red appears, may be read. The mean between these two points may then be marked down as the required

point of neutrality. The utmost point at which a distinctly alkaline reaction is preserved may be marked down, or the earliest point of distinct redness may be taken. Of these three methods, I prefer the second for titrations involving organic acids, and have employed it in the following examples :—

In determining the quantity of standard sulphuric acid necessary to neutralise the volume of alcoholic potash, I have read off the utmost point of distinctly alkaline reaction, and in afterwards reading off the quantity of acid required to neutralise the *residual* potash, I have also read off the utmost point of distinctly alkaline reaction. By this device the difficulty of the exceedingly faint acid reaction of the organic acids is eluded.

Benzoate of Ethyl.

1. 6·166 grm. taken; volume of alcoholic potash neutralised 62·1 c. c. of standard acid; residual potash, after the action of the ether, neutralised 10·2 c. c. of standard acid; 1 c. c. of standard acid corresponds to 0·03062 grm. of potassium. From these data, 100 grm. of benzoic ether neutralise 25·77 grm. of potassium.

2. 4·1580 grm. of benzoic ether taken; result, 100 grm. of benzoic ether neutralise 25·78 grm. of potassium. Theory requires 26·06 grm. of potassium.

Butyrate of Ethyl.—I. Ether taken = 2·020 grm.: result, 100 grm. neutralise 34·10 grm. potassium. II. Ether taken = 2·009 grm.; result, 100 grm. neutralise 33·98 grm. potassium. Theory requires 33·70 grm. potassium.

Valerianate of Ethyl.—I. 3·4530 grm. taken; result, 100 grm. neutralise 30·15 grm. potassium. II. 2·5181 grm. taken; result, 100 grm. neutralise 30·77 grm. potassium. Theory requires 30·08 grm. potassium.

Diethoxalate of Ethyl.—$\left\{\begin{array}{l} CO(C_2H_5O) \\ C(C_2H_5)(C_2H_5)(HO) \end{array}\right.$—2·7580 grm. taken; result, 100 grm. neutralise 24·20 grm. potassium. Theory requires 24·44 grm. of potassium.

ROYAL INSTITUTION OF GREAT BRITAIN.

ON MILITARY BREECH-LOADING SMALL ARMS.

By Captain V. D. MAJENDIE, R.A., Assistant Superintendent, Royal Laboratory.

Those who believe that breech-loading rifles formed no part of the equipment of the British army until the present or the past year—that they sprang directly out of the performances of the needle-gun in the late Bohemian campaign, will learn with surprise that not only had breech-loading been determined upon for our infantry nearly three years ago, and the actual pattern of arm that is now in the hands of a large proportion of our troops decided upon a full month before Königgratz was fought, but that two regiments of English cavalry were provided with a breech-loading carbine ten years ago. If we examine one of these Sharp's carbines, as they are called, we notice at once an objectionable feature, viz., that the ignition is effected by means of a percussion cap. Then again, the arm is provided with no effective arrangement for checking the escape of gas. So great is this escape, that a handkerchief laid over the breech at the moment of firing will be burnt through and through: whereas with a close-fitting arm or cartridge the handkerchief should not be even soiled by the discharge. This defect is aggravated by the quantity of powder, which in damp weather adheres outside the breech after loading. The back end of the cartridge is cut off thus, and the powder sprinkled about. From these two causes, the firer's face is generaly flecked and burnt in firing; while the escape of gas tends also to foul and clog the breech action, which exposes large friction surfaces, and to render the arm more difficult to open as each round is fired. For these reasons: the retention of the percussion cap, the liability to an escape of gas, the flash occasioned also by the spilt powder, and the difficulties which often arise in loading, this system is extremely imperfect. And yet this system did undoubtedly reflect to some extent the state of feeling which prevailed in this country on the subject of military breech-loading arms a few years ago. For at that time this question was regarded exclusively as a cavalry question, and quick shooting was scarcely thought desirable for a cavalry soldier. . . . . .

Between 1857 and 1861 three other breech-loaders were introduced for experimental cavalry use. One of these, the Green's carbine, even in that easy age, never obtained a footing as a recognised service arm. But the Terry's carbine was introduced to some extent, and is not yet entirely obsolete; and the Westley Richards' carbine has found justly more favour. In 1861 this arm was definitely adopted. It is a great improvement on the others which I have named. It is an accurate arm; it fires six or seven rounds a minute with comparative ease and certainty; it spills no powder; it does not burn the firer's face or facings. Until the recent competition, Westley Richards' was accepted as the best type of military breech-loading arm known in this country and, with its many objections, I would still pronounce it one of the most effective capping breech-loaders which have been produced.

But we have now to consider the subject in a broader light. It had been treated hitherto from one narrow point of view—as almost exclusively a cavalry question. We had considered only arms of which the percussion cap formed a material element, and a copping arm may be pronounced, with our present knowledge and for our present purpose, only half a breech-loader. Thus far, then, we may justly say that breech-loading had been cramped within contracted limits and misunderstood. But a couple of years or so ago the whole aspect of the case altered. As by a revelation we learnt then what breech-loading really meant, and of what development the system was capable. It was a great epoch for breech-loading, its Hegira, it might be called, when it was discovered that the objections to cartridges containing within themselves the means of ignition had in reality no force. If we are to trace the stagnation which had hung over the question to a definite cause, we may confidently place our finger upon these objections.

When men said, and the ablest and most experienced military men did say, and our military authorities laid it down as a fundamental axiom, that cartridges containing their own ignition were not admissible for military use, what they meant was: 1st, that such cartridges were more liable than others to accidental explosion; and 2nd, that in the event of the explosion of one cartridge, the contents of the barrel were liable to be all exploded *en masse*, and so to communicate from barrel to barrel. If we grant these premises, the conclusion is just. Ammunition which is liable to explode in bulk, and thus not only to commit injury and dangerous havoc for the moment, but by its explosion to deprive the troops dependent upon it of their supplies, is clearly not admissible for military use. But when, mainly, I believe, by reason of the explosion of gunpowder at Erith two years and a half ago, men's minds were directed towards explosions generally, an experiment was made to determine the liability of small arm cartridges—not breech-loading cartridges in this case, but the ordinary muzzle-loading Enfield rifle cartridges, ball and blank—to explode in bulk, and it was established not only that the explosion of a single cartridge in a barrel was not communicated to the rest, but that the explosion of a number of cartridges, or even of ¼lb. of loose powder, although it might burst open and destroy the barrel, would not occasion a general explosion. Although the bearing of this fact upon the question of breech-loading was not immediately perceived, it furnished the opening through which presently a flood of strong new light rushed in upon the subject.

This effect proceeds from the same cause as that which operates in rendering the well-known Gale gunpowder inexplosive. Mr. Gale enclosed each grain of his powder in an incombustible envelope of finely powdered glass or bone-dust. In a barrel of cartridges we have not each grain enveloped, but a number of grains, so many as compose one charge, in a non-combustible case. I have tried over and over again to explode a barrel of the service breech-loading cartridges without success. I have several times fired one cartridge in a barrel without igniting the remainder. I have fired ten cartridges at once, and no more have fired. I have gone further, and placed the barrel inside an iron cylinder, tightly screwed down, and have exploded ¼lb. of powder in the midst of the 700 cartridges which it contained; and although the screws were broken and the lid of the cylinder was blown off with violence, and some of the cartridges were strangely distorted, none of the cartridges were ignited. Experiments not less exhaustive have established also the non-liability of these cartridges to separate accideutal ignition, by concussion or otherwise. In this way we dispose of the objections which have been entertained against cartridges containing their own ignition, and establish their admissibility for military service. . . . . .

Between 1859 and 1864, no less than twenty-six different plans of breech-loading were proposed. For sporting purposes, too, breech-loading guns had found their way into very general use, and in America they were being largely applied experimentally for military service. But always this shadow hung over the question; that cartridges containing their own ignition were not generally considered admissible for military use. And as breech-loaders not adapted for such ammunition presented comparatively few advantages except for cavalry, for whom as I have explained quick firing was not specially desired, and as the development of the system was thus stunted' the question was in fact argued in a circle, and the subject remained up to this period practically at a standstill.

But when once this fatal restriction and limitation were removed—we began at once to make real progress in the matter. It was no longer a question merely of an arm which presented certain minor facilities of manipulation—of an arm somewhat handier to load on horseback—but it became obviously a question of an arm, which would multiply the fire of an army three or fourfold—which, properly considered, would place as it were three or four rifles in each soldier's hands.

In the course of the Dano-German war the value of the famous needle-gun, or rather of the system of which the needle gun was an indifferent exponent, became in the eyes of observant men fully established. So obvious was the teaching of this campaign, that our then Secretary of State for War, Lord de Grey, appointed forthwith a committee, with General Russell as president, to "report upon the advisability of arming the infantry, either in whole or in part, with breech-loaders." After four meetings this committee reported, abstractedly and without reference to any particular system, that it would be desirable to arm the whole of the infantry with breech-loading rifles; and on the day on which this report was drawn up, the 11th July 1864, the death warrant of muzzle-loading rifles for the use of the British soldiers may be regarded as having been signed.

The next question to be considered was, how to give effect to the recommendations of the committee. This question admitted of consideration in two ways: either by itself with a view to ascertain the speediest and cheapest mode of placing a breech-loader in the hands of the troops, or in combination with other questions connected with rifles, such as the best size of the bore and the best mode of igniting the cartridge, and with a view to determine what would be, in all respects, the most perfect arm for the use of the infantry. The first mode of dealing with the question would have the advantage of celerity, the second of completeness. But why not have combined the two, by arming the British army immediately with the needle gun? Here was a complete system—a good system perhaps, some will say, ready-made to our hand; a system, too, which had had the advantage of being tried on actual service, and which, if economical considerations were to have any weight, had been adopted by a nation very much less able to bear heavy expenditure than ourselves. I have here a needle gun, which will, I think, answer this question for itself. Take the gun as it stands, and tell me—those of you at least, and I doubt not there are many who are accustomed to handle the beautiful weapons which England puts into

the hands of her soldiers and her volunteers and her sportsmen—tell me if this clumsy rifle is one which you would have cared to see issued to our troops. But why not, you will say, improve the workmanship of the piece—make it lighter, balance it better, alter its bore if need be, or its mode of rifling, improve its mechanism, and when you have suited it to the more advanced requirements of this country, adopt it?

Need I point out to you that such a measure would have disposed of the first adoption of the arm. We are no longer in this case adopting a system ready made to our hands. We are in fact creating one. We are adopting a breech mechanism, merely one element of a system, nothing more. And but little knowledge of the subject was needed to instruct us as to the extremely defective nature or principle of this breech mechanism. If I handle the needle gun, you will see that it is comparatively slow. It is clumsy and imperfect in other ways. The needle with which the cartridge is ignited is very liable to become bent or injured. I shall be reminded that these needles are easily replaced, that each Prussian soldier carries two or three. But this injury and replacing of a needle temporarily disables the arm, and constitutes, it must be admitted, an objection. Then, again, the gas-check is not permanently reliable. The whole escape is thrown upon the arm, at the junction of the breech, none upon the cartridge; and even if we set out with a tight fit, the fit will become less and less close, and in time, if the arm be not carefully looked to and repaired, an inconvenient escape of gas will occur—an escape which sometimes induces the Prussian soldier to deliver his fire by preference from the hip. Of the ammunition it will be sufficient to say that it is rude, and for technical reasons ill-adapted for the requirements of military service. The egg-shaped bullet is embedded in a small papier-maché wad, which serves the double purpose of rifling the bullet, which never touches the grooves, and of containing the fulminate, which the needle, penetrating the powder and the thin paper envelope which encloses the whole, has to pierce. In short the needle-gun, however superior even to a *good* muzzle-loader, was not such an arm as we should have been justified in adopting, except in an emergency more pressing than that which now presented itself.

Of the other systems of which we had any experience, and which you have seen, there was none which seemed calculated to satisfy our requirements, and their adoption was accordingly not entertained.

Under these circumstances, having no complete system to begin upon, we determined to take so much of a known and reliable system as we approved, and apply it. By this course we should get, as it were, a lift upon our road, and start somewhat in advance of the point from which we must set out, if we elected to consider the question *ab ovo*. Therefore, and without prejudicing the ultimate and more leisurely investigation which the question as a whole demanded, we resolved to take so much of the existing arm—the Enfield rifle—as seemed to us good, and to revolutionise that part of it which we deemed bad. We determined, in short, to convert our Enfield rifles into breech-loaders. In speaking of the Enfield rifle as a good arm, I am anxious not to be misunderstood. It is an arm, doubtless, with many defects, if we judge it by the rigid standard of more modern requirements. A steel barrel, for example, would probably be preferable to a wrought-iron barrel; the Enfield twist is undoubtedly too slow for extreme accuracy; and the calibre may be considered as unnecessarily large. The refinements and progress of gun-making have left the Enfield rifle to a certain extent behindhand, just as the refinements and progress of breech-loaders have left the needle-gun behind; and yet in the main it is an excellent weapon for military use, and I know no Power whose soldiers possess a muzzle-loading rifle which can compare with it. We do not, recollect, require a match-rifle for military purposes. Except, on a few rare occasions, such an arm would have no special value. It was Lord Palmerston, I think, who pointed out that what the soldier is required to do is, not to hit a particular button upon his enemy's coat, but generally to drive home an effective fire into an opposing body of infantry or cavalry. . . . . Instructed then by the sober teaching of actual warfare, we were justified, I think, in assuming that if to this Enfield rifle, without subtracting from its accuracy and other qualities, we could apply an effective breech-loading arrangement, we should be at once relieved of all pressing anxiety, and in a position to select leisurely a new and superior breech-loader for future manufacture. Moreover, there were more than half-a-million of these muskets available for conversion; and the step which was proposed had the secondary, but by no means inconsiderable, advantage of economy. It had other subordinate advantages, such as the experience in breach-loading equipment to be derived in the course of the inquiry, and which might stand us in good stead when the more complete and difficult question should come before us, and finally the avoidance of the danger of hurrying without due consideration into the adoption of a possibly unsatisfactory arm.

In August, 1864, an advertisement was issued, inviting gunmakers and others to submit propositions for the conversion of the Enfield rifle. From the fifty systems which were sent in, in reply to this advertisement, those which were obviously unsuitable were eliminated, and eight systems were selected for trial, of which five only, for reasons which it is unnecessary for me to detail, ultimately came to the post. Of these, four were capping arms, one only a non-capping arm. The selection for trial of these capping arms indicates that we were not then quite as advanced or decided upon this point as we are now, and had not yet absolutely learned to regard non-capping as a *sine qua non*. So Westley Richards', Mont Storm's, Wilson's, and Green's converted Enfield rifles entered the lists against the solitary representative of the non-capping system—the Snider rifle.

Westley Richards's converted Enfield was substantially the same in respect to its breech mechanism as the cavalry carbine which I have shown you, with the addition of a small hook at the end of the plunger for withdrawing the wad after firing.

In Wilson's arm the breech of the original rifle is removed, and the barrel prolonged for some inches in the form of an open slot. The cartridge is inserted here and pushed forward into the barrel, and is followed by a sliding plunger which is fixed after loading by a stout bolt which passes through stock and plunger. There is an india-rubber ring to diminish the escape of gas.

The Green rifle resembled the Wilson, except in the manner of securing the plunger, which is furnished with a small knob, and is turned round after loading a quarter circle, and so locked.

The Montgomery Storm or Mont-Storm arm is one of that class of breech-loaders known as "chamber-loaders." A chamber-loader is in fact a sort of muzzle-loader cut short, or so arranged that the arm can be conveniently loaded by hand, without the assistance of a ramrod. The charge is deposited in a short chamber, instead of being rammed all the way down a long barrel; and the chamber is then replaced in the position for firing in the prolongation of the barrel. Of breech-loaders on this plan there are many modifications. In this arm the hinge is in front of the chamber; in many rifles (the Swedish rifle for example) it is behind, and that would probably be the most primitive form of chamber-loading. Colt and Deane and Adam's revolvers are examples of chamber-loading arms having several chambers. In these arms, the chambers are not hinged but revolve, and are brought in succession into prolongation of the barrel. I have several other examples of chamber-loading arms here, to which I would invite your attention after this discourse. The chamber of the Storm rifle can be turned completely over the breech, and loaded; or it may be swivelled at right angles to the barrel for loading with loose powder. When the chamber is returned, it is secured by a bolt worked by the lock, and an escape is prevented by an expanding ring or thimble on the pan of the chamber.

In the first arms made on the Snider system, about two inches of the upper side of the breech end of the barrel were cut away, leaving a wide open slot or breech for the admission of the cartridge. When the cartridge had been pushed forward into a taper chamber formed by enlarging what was now the hind part of the barrel, the slot was closed by a lump of steel, hinged on the right side of the barrel, and forming a false breech. It was afterwards found more convenient to remove the back part of the barrel bodily, and to replace it with a "shoe," in which the whole of the breech arrangement was comprised; other modifications followed, until we got at last the more perfect arm, which I hold in my hand. The breech block, you will see, hinges upon this pin and works thus. It is kept in its place by a small spring stud; and the fit of the block tends also te hold it. In order to meet a possible objection that this arrangement is liable to wear and get out of order, I have brought a "shoe" which has never even been hardened, but which has fired at least 30,000 rounds, and still remains, perfectly serviceable.

The ignition is effected by means of a small piston or striker, which passes through the breech block, and which, when in repose, is flush with the face of the block. A blow of the hammer causes it to dart forward about a tenth of an inch into the cap, which is fixed, as I shall presently more particularly explain, in the base of the cartridge. The piston is returned by a spiral spring. To withdraw the empty cartridge case, a claw or extractor forms part of the breech block. When I withdraw the block, the empty cartridge is necessarily drawn with it, and by canting the rifle sideways the case is thrown out. The extractor is returned by another spiral spring. With regard to this spring, to which objection has been taken, I would point out that it is negative, not positive, in its action. The spring in the needle gun is positive, and the action depends upon it. In this gun, the spring is an auxiliary merely, not an essential. We can do without the spring. It is better to have it; but if we have it not, if it becomes damaged or inert, the extractor can be pushed back by hand. And lastly, the spring in this case is never repressed to a greater extent than about one-tenth of an inch.

It has been stated lately that the Snider system was not really invented by Mr. Snider at all, but by M. François Eugène Schneider; or to go further back, by Mr. John Poad Drake, a Cornishman. But if we are really to trace the system to its source, we must go back to a time which places the invention quite beyond the reach of living men. I have thus far not ventured on the archæology of breech-loading; but if you will permit me, I will make one dive into antiquity for the purpose of bringing under your notice two breech-loading firearms of the reign of Henry VIII., on the Snider system! By the kindness of Admiral Caffin, these interesting arms have been lent to me from the museum of the Tower, for the purpose of exhibition.

In the course of the competition the Snider gun proved about 50 per cent. quicker than its rivals; it was stronger too; it was simple, and apparently durable, the breech arrangement being well adapted to sustain the shock of any number of discharges, from the fact of those shocks being sensible only in a direction at right angles to that in which a force must be exerted to open the breech; and lastly—I should perhaps have placed this advantage first, not last—it was adapted for a cartridge containing its own ignition.

Among the capping arms, the Mont-Storm rifle was ranked first, and was recommended for experimental application to a certain number of rifles. The system failed subsequently at proof, and the recommendation was cancelled. It failed partly on account of the unsuitability of the skin cartridge which formed part of the system; and this reminds me of another objection to which all capping arms are open. Such arms need a cartridge so thin, that the fire from the cap shall pierce it, and at the same time the cartridge must be so entirely consumed or carried out by the discharge, as to leave no residue to endanger or interfere with loading. These requirements make it difficult to satisfy another not less important point in a military cartridge, viz.: that it shall be strong enough to stand the knocking about to which it will inevitably be exposed in transport and on service. Moreover, a thin cartridge is evidently less well adapted than a stout one to resist the effects of an accidental adjacent explosion. But the Mont-Storm rifle failed also in the arm itself. Under proof charges, the hinge and small bolt by which the chamber is locked were broken.

The Snider rifle, while satisfying many requirements, failed in one important respect. It was so inaccurate as to be quite unsuitable for adoption as it stood. . . . .

As the fault could not lie in the barrel, which the accuracy obtained under the

other systems showed could be converted without detriment in this respect, it was due obviously to the ammunition which Mr. Snider had submitted. At this point, then, the question of providing more suitable ammunition for the arm was referred to Colonel Boxer, by whom, after a year's experiments, the present service ammunition was designed. Discarding the papier-maché case submitted by Mr. Snider, the objections to which, especially in damp weather, are well known, Colonel Boxer made the case of his cartridge of very thin sheet brass, ·003″ thick. The cartridge has a little over two turns of this brass.

Five important advantages result from the employment of this case:—1st. Being uncoiled slightly by the explosion, instead of depending upon the mere stretch of the material, the case can be used in a chamber considerably larger than itself, with little danger of breakage and consequent escape of gas. 2nd. It is not liable to swell with damp, and so to interfere either with loading or withdrawal. 3rd. The difference between the size of the case and of the chamber is so considerable as to permit of loading even when the case has become considerably enlarged or disfigured by rough usage. Nor under these circumstances again is there any danger of leakage or escape. 4th. Such a cartridge may be made like the present service cartridges, practically waterproof. 5th. The reaction, or tendency of the case to recoil, which arises after the pressure of gas is removed, tends to render a case of this sort easier of extraction than any other. All of these advantages hold good against a papier-maché case; many of them hold good also against a case of simple copper or other metal.

. . . .

The last point to be noticed in the ammunition for the Snider rifle is the bullet. On this the accuracy of the fire of the arm depends. The bullet is not made, as in the majority of breech-loading arms, slightly larger than the bore, but depends for its action upon the system of expansion which Colonel Minié was, I believe, the first practically to adopt, viz., a hollow on the base, together with a plug, by which the original Minié iron cap has been superseded. This plug, which is now made of baked clay, plays the double part of expanding and supporting agent. The expansion of the bullet would be effected, it is true, to a great extent by the simple action of the powder-gas upon the sides of the hollow. But a plug makes that expansion more instantaneous and more uniform, and, above all, it supports the sides of the bullet after expansion. Thus, with a plug the passage of the gas is prevented and fouling diminished, in the first place; and in the second, even when fouling has been established, its effect upon the accuracy of a plugged bullet, whose sides do not collapse when they come into contact with the obstructing deposit, will be much less than upon an expanded bullet which has no plug.

Another important feature of the bullet is the wood plug in the head. By this plug we obtain three advantages—greater length, and so a broader bearing and lubricating surface; secondly, the centre of gravity is more favourably adjusted with reference to the requirements of the projectile and the slow twist of the piece; thirdly, the weight is disposed, as in the fly-wheel, away from the axis of rotation.

Round the bullet are disposed grooves or cannelures, which serve to carry the bees' wax lubricant, by which means a layer of wax is always interposed between the lead of the bullet and the sides of the bore; and fouling is so completely got rid of that one of the best targets ever made with this arm was made after 1,000 rounds had been fired from it without cleaning. This point is one of extreme importance, for the accuracy of a military arm is to be measured by its average accuracy during a long sustained fire, and not by its performances when perfectly clean. The measure of efficiency of a military arm in this, as in other respects, is to be obtained by taking the arm, not at its best, but at its worst. In other respects the ammunition satisfied the tests which were imposed. It stood an extraordinary amount of rough usage. It was waterproof to an extent which enabled it to be kept for a whole week in wet sawdust without injury; it was easy of extraction, not liable to escape or explosion; and its expense is very little greater than that of a paper cartridge, even if we take its first cost merely, and immeasurably less if we spread the cost over the periods during which the two ammunitions would respectively remain serviceable—if, indeed, the paper cartridge could ever be considered serviceable. The extreme rapidity of fire in the arm is fifteen shots per minute. Of this ammunition about eight millions of rounds have been issued up to the end of last week, and of the arms in round numbers 100,000. To deal with the false and exaggerated reports which have been circulated respecting the "failure" of the Snider system is a task which I cannot undertake, except in a general way. I can only say that in essence and in substance these reports are false. There have been difficulties of detail, it is true, but fewer and less serious difficulties, I believe, than have ever attended the introduction of any new system of guns or small arms; and whereas the general tenor of the misstatements to which I refer has been that the system has failed, the general tenor of the reports of the troops, in Canada, at Hythe, and at Aldershot, to whom the arms have been issued, has been that the system has proved, on the whole, and specially with reference to the cartridge and the breech action, admirably successful. It may tend, perhaps, to restore confidence also, if I state that the percentage of failures out of a total of about 50,000 rounds of ammunition, which, in the course of my duty, it has fallen to my lot to fire since the arms were introduced, has amounted to little over one failure in every three hundred cartridges, including every defect, however slight—every miss upon the target at 500 yards, every misfire, every cartridge which has split or failed from any cause. And out of more than 20,000 rounds fired by the Ordnance Select Committee, the percentage of failure has been, I believe, even less.

Breech-loaders may be divided into two great classes:—(*a*) breech-loaders, in the ordinary acceptation of the term; and (*b*) repeaters.

The first class may be further subdivided into (1) chamber-loaders, and (2) breech-loaders proper. Of chamber-loaders I have already shown you two examples, the Mont Storm and the Hägström. I have here several others, such as a Spanish arm (Garcia's), Bergstrom's, and another Norwegian system; Leetch's, Mackenzie and Wentworth's, &c.

The more conspicuous defects of this class of arm would seem to be their liability to injury by the explosion, which generally acts directly upon the breech mechanism. On the other hand, they are generally perfectly free from escape of gas, except sometimes at the junction of chamber and barrel. In Sweden and Norway chamber-loaders find more favour than in this country.

Breech-loaders proper include more numerous types of arms. The Snider rifle is an arm of this class; so is the Westley Richards, the Terry, the Sharp, the Green, the needle-gun, all of which you have seen. I have here several others, some good, some bad, some celebrated in their way, and some which exhibit the imperfections of which the system is capable. The Amsler-Milbank system (adopted by the Swiss Government for conversion), Joslyn's, Bayliss's, Restell's, Beard's, Bruton's. Prince's, the Starr carbine (now in use in Canada), Fosbery's, Laidley's (adopted in Russia), are all examples of breech-loaders proper. In these arms, as a rule, very much more work is thrown upon the cartridge. Where, as in the needle-gun and the Sharp carbine, the escape is sustained by the gun, and not by the cartridge, the system will generally be open to objection on the score of excessive escape of gas. With secure ammunition, this defect may be entirely got rid of, and to me it seems sounder in principle and more reliable in practice to throw the burden of the escape upon the cartridge, which only has to sustain it once, than upon the arm, which must sustain it many hundreds or thousands of times.

(*b*) Repeaters may be subdivided into (1) revolvers, and (2) magazine arms. Of revolvers the best examples are furnished by revolving pistols, of which, by the addition of a long stock and barrel, rifles have sometimes been made. I have here also a revolving carbine, by a Colonel Porter. The system is open to many objections, among which, except for pistols, the weight of the several chambers is conspicuous.

Of magazine arms there are two important varieties: The simple repeater, such as Henry's, in which the cartridges are constantly drawn from a magazine under the barrel, which must be replenished from time to time as it becomes exhausted; and, secondly, an arm which, like the Spenser and Lamson rifles, can be used as repeater or simple breech-loader at will. In these arms I can, if I wish, shut off the magazine, and load them as ordinary breech-loaders. This plan presents several important advantages over the ordinary repeater, which entails distinct intervals of inefficiency while the magazine is being replenished, and which directly tempts the soldier to indulge in an excessive rapidity of fire while his magazine supply lasts. But in the improved repeaters these objections are obviated. I have here, for example, the Lamson rifle, with its magazine full. I need not, however, call upon the magazine, but I may load as if the arm were an ordinary breech-loader. Then, when pressed, I can, so to speak, turn on the tap of the magazine, and pour forth such a fire as no simple breech-loader can deliver. When my magazine is exhausted, I am not, as with an ordinary repeater, temporarily disabled; for I can fall back upon the simple breech-loading action, until an opportunity presents itself for replenishing the magazine against another emergency. So with the Spenser rifle, in which the magazine is situated in the stock.

The direction in which repeaters generally err, is in complexity of construction; but if this defect can be overcome, a magazine-rifle would present immense advantages over the simple breech-loader, not merely for those services, such as the navy, the cavalry, and artillery, in which an intensely rapid fire is generally required for a few decisive moments, but for the universal equipment of troops. It is in arms of this class that breech-loading tends towards its highest development; and to this principle of action I believe we must look for the complete and ultimate solution of the breech-loading question.

The advantages which breech-loading presents in a military rifle are—

First, rapidity of fire. We give each soldier, so to speak, and as I have before expressed it, three or four rifles, with the inconveniences only of one. At close quarters no troops, however brave, devoted, or disciplined, could stand with muzzle-loaders against a corresponding force armed with breech-loaders. It amounts to being opposed to a force whose numbers are practically multiplied by the figure which expresses the ratio of rapidity of fire of the breech-loaders to the muzzle-loaders. We must not press this argument too far. It will hold generally when the fighting is quick, and close, and decisive, and when the conditions of the contest on both sides are the same. But breech-loaders will not do everything; and we must avoid the error of supposing that they did everything in the Danish or Bohemian campaigns. The needle-gun was but the embodiment of that spirit of *geist* and progress which animated the Prussian army and its leaders, which dictated the execution of their rapid movements, and which was the soul and essence of their superior organisation. Especially must we avoid the too close application of mere abstract reasoning when the element of artillery fire comes into play. Eleven years ago an experiment was made at Hythe with life-size dummy figures of men and horses, which went to prove conclusively that artillery would be beaten off the field by infantry armed with rifles. This drawing shows what was then proved, that a detachment coming into action would be annihilated in three minutes by thirty file of riflemen. But two important considerations were overlooked: that in actual warfare infantry would scarcely deliver so effective a fire as then served to plant at 800 yards' range thirty-four shots in a single gun detachment—just as two men standing opposite one another at twenty paces to fight a duel often fail to hit one another, while at a very much greater distance they can each easily break a bottle's neck in a pistol gallery. And, secondly, the necessity for artillery coming within this range at all was not established; so that the reasoning which was based upon these premises fell in practice to the ground; and notwithstanding improved musketry instruction and improvements in the arms, the use and importance of artillery have in nowise diminished since the introduction of the rifle for general service: so those also would be mistaken who might argue from this diagram that if so much could be done with muzzle-loading rifles, firing as they did on this occasion one round per minute only, breech-loaders firing seven or eight rounds per minute would produce a corresponding effect, and that the predominance of artillery fire in an action must

henceforth cease to exist. But within reasonable limits the effects of breech-loaders, as opposed to muzzle-loaders, can hardly be over-estimated. It must be remembered, too, that there is always attendant upon the employment of a more effective arm a moral as well as a physical effect. As Marshal Marmont said, a battle is decided, after all, not by the number of men killed, but by the number frightened.

By a converse application of this argument we reach the second great advantage of breech-loading, increased confidence, a point upon which I need not dwell, but of which all military men will recognise the importance.

Thirdly, we obtain greater facility in loading. On horseback, breech-loading, even of an imperfect kind, is vastly superior mechanically to muzzle-loading. For the infantry man, if we reflect a moment, the advantages will appear quite as great. Whatever the soldier's position, whether lying behind some sheltering mound, cramped in a rifle-pit, working in close squares, with his bayonet presented to resist cavalry, or running forward as a skirmisher, he can load a breech-loader as he could never load a muzzle-loader—without exposing himself, without changing his position, without inconvenience or loss of time or effect.

We have, in the fourth place, improved shooting. The arm is always loaded in a position which favours the subsequent delivery of a low and effective fire. The eye is never removed from the object, and no part of the powder can be spilt, no part can be lodged in the grooves of the rifle; while the increased confidence of which I have spoken, tends to steady men's arms and improve their aim. It has been objected that the rapid firing of the breech-loader will tend to tire and unsteady men's arms, but surely this objection, if it has any force, may be met by the consideration that the operation of loading a breech-loader is very much less fatiguing.

Fifthly, the possibility of overloading is avoided. This, in the hurry and excitement of action, is no uncommon accident. A man loads, and, as he thinks, fires. His cap misses fire, or he even neglects to cap at all. But he does not at once recognise it. He rams down another charge, perhaps another, &c. After one of the American battles several arms were picked up loaded with two charges, others with three; some with four, and a few even with eight!

Among the minor advantages of breech-loaders, I may name the completeness and compactness of the ammunition; the facilities for cleaning and inspecting the arms; the ease with which the drill may be acquired; the diminished danger in loading; and the possibility of the arm being rendered inefficient by the loss of a ramrod.

It has been said that breech-loaders will entail an excessive expenditure of ammunition. But, in the first place, we have no grounds for supposing that the ammunition expended will be wasted; and a similar argument would have held against the supersession of the old flint-lock by the percussion cap. If the fire be delivered at such ranges that the shots tell, it merely amounts to this, that the work is done with the new system so much quicker and more effectually than with the old; and experience teaches us that the requisite supply can be kept up without difficulty, even in a long, hot, general action, and that this objection has been much overrated. It is stated, indeed, that the greater coolness and confidence of the men tends rather to a less expenditure; and the number of rounds fired by any individual Prussian soldier in the late campaign, if figures are to be relied upon, would seem to favour this view. The supply of ammunition, whatever its expenditure, is, however, only a question of organisation; its efficient expenditure is a matter of instruction.

ON THE VARIOUS MODES OF FLIGHT IN RELATION TO AERONAUTICS.

By Dr. JAMES BELL PETTIGREW, M.D. Edin., Assistant Curator of the Royal College of Surgeons of England Museum.

The subject of flight, natural and artificial, is one which has occupied the attention of mankind from a very early period.

It involves a more or less intimate acquaintance with anatomy, physiology, mechanics, and the higher branches of mathematics.

If regarded as a natural movement, it forms one of the three kinds of locomotion by which animals progress—the remaining two being walking and swimming; if regarded as an artificial one, it represents the unsolved problem of that grand trio which has for its integral parts the locomotive, steamboat, and flying-machine. Had time permitted, it was my intention to have gone into the subject of locomotion at length. I find, however, I must curtail my remarks under this head, which I do with reluctance, from a feeling that the chain of animal movements, like the great chain of existence, winds in and out and doubles upon itself so completely as to render a partial examination of it in many respects unsatisfactory.

The movements of animals are adapted either to the earth, the water, or the air. There are others, however, of a mixed character, where they are suited equally to the land and water, or even to the land, water, and air.

The instruments by which locomotion is attained are therefore specially modified.

This is necessary because of the different densities and the different degrees of resistance furnished by the land, water, and air respectively.

As the earth affords a greater amount of support than the water, and the water than the air, it requires a greater degree of muscular exertion to swim than to walk, and a still greater one to fly.

For this reason flight is the most laborious, and in some respects the most complicated and difficult of all the animal movements.

The peculiarities of the different media, as far as locomotion is concerned, may be briefly stated.

On the land we have the maximum of resistance and the minimum of displacement.

In the air, the minimum of resistance and the maximum of displacement.

The water is intermediate in these respects.

As a consequence, the feet of land animals are small—their bodies large. The horse and deer furnish examples.

In those land animals which take to the water occasionally, or the reverse, the feet are enlarged and usually provided with a membraneous expansion between the toes. Of such, the otter, ornithorhynchus, seal, frog, turtle, and crocodile may be cited.

In addition to the land animals which run and swim, there are some which precipitate themselves, parachute fashion, from immense heights, and others which even fly. In these the membraneous expansions are greatly increased—the ribs affording the necessary degree of support in the dragon or flying lizard, the anterior and posterior extremities in the flying lemur, flying cat, and bat.

Although no lizard is at present known to fly, there can be little doubt that the extinct pterodactyles, which are intermediate between the lizards and crocodiles, were possessed of this power.

The bat is interesting as being the only mammal at present enjoying the privilege of flight; it is likewise instructive as showing that flight may be attained without the aid of hollow bones and air-sacs, by purely muscular efforts and by the mere contraction and dilatation of a continuous membrane.

If we now direct our attention to the water, we find that the amount of surface engaged in locomotion greatly exceeds that in the amphibia. The fish furnishes the best example.

In it the lower half of the body and the broadly-expanded tail are applied to the water very much as an oar is in sculling. The sea-mammals, as the whale, dugong, manatee, and porpoise, swim in precisely the same manner as the fish, with this difference, that the tail strikes from above downwards, or vertically instead of horizontally, or from side to side. The seal is exceptional in this respect.

The animals which furnish the connecting link between the water and the air are the flying fishes on the one hand, and the diving birds on the other: the former sustaining themselves for considerable intervals in the air by means of their enormous pectoral fins, the latter using their wings for flying above and beneath the water, as occasion demands.

I have carefully examined the relations, structure, and action of the fins in the flying-fish, and am of opinion that they act as true pinions; their inadequate dimensions only preventing them from sustaining the fish for an indefinite period in the air, at all events so long as they remain moist. They operate upon the air from beneath, after the manner of a kite or spiralifer, and in so doing, lever the animal upwards and forwards.

If they did not act as true pinions within certain limits, it is difficult and indeed impossible to understand how such small creatures could obtain the momentum necessary to project them a distance of 200 or more yards, and that sometimes at an elevation of 20ft. above the water.

In birds which fly indiscriminately above and beneath the water the wing is generally provided with stiffer feathers than usual, and reduced to a minimum as regards a size. In subaqueous flight the wings may act by themselves, as in guillemots, or in conjunction with the feet, as in the grebes; but in either case it is the back or convex surface of the wing which gives the effective stroke, the wing in such birds as the great auk, which are incapable of flight, being for this purpose twisted completely round, in order that its concave surface which takes a better hold of the water may be directed backwards.

The wing therefore operates very differently in and out of the water.

In the water it acts as an auxiliary of the foot, and both strike backwards and downwards.

In the air, on the contrary, it strikes downwards and forwards, and this is a point deserving of attention as showing that the oblique surfaces presented by animals to the water and air are made to act in opposite directions. This is owing to the greater density of the water as compared with the air; the former supporting or nearly supporting the animal acting upon it; the latter permitting the animal to fall through it in a downward direction.

But to come to the subject more particularly in hand, viz.:—

Flight in its relation to Aeronautics.—The atmosphere, because of its great tenuity, mobility, and comparative imponderability, presents little resistance to bodies passing through it at low velocity. If, however, the speed be greatly increased, the action of even an ordinary cane is sufficient to elicit a recoil.

This comes of the action and re-action of matter, the resistance experienced varying according to the density of the atmosphere and the shape, extent, and velocity of the body acting upon it. While, therefore, almost no impediment is offered to the progress of an animal in motion, it is often exceedingly difficult to compress the air with sufficient rapidity and energy to convert it into a suitable fulcrum for securing the onward impetus. This arises from the fact that bodies moving in this medium experience the minimum of resistance and occasion the maximum of displacement. Another and very obvious difficulty is traceable to the great disparity in the weight of air as compared with any known solid (this in the case of water, being nearly as 1000 to 1), and the consequent want of buoying or sustaining power which that disparity necessitates. To meet these peculiarities, the insect and bird are furnished with extensive surfaces in the shape of pinions or wings, which they can apply with singular velocity and power at various angles, or by alternate slow and sudden movements, to obtain the necessary degree of resistance and non-resistance. Their bodies, moreover, are constructed on strictly mechanical principles: lightness, strength, and durability of frame; and power, rapidity, and precision of action, being indispensable. The cylindrical method of construction is consequently carried to an extreme; the bodies and legs of insects displaying numerous unoccupied spaces, while the muscles and solid parts are tunnelled in every direction by innumerable air-tubes, which communicate with the surrounding medium by a series of apertures termed spiracles.

A somewhat similar disposition of parts is met with in birds, these being in many cases furnished not only with hollow bones, but also (especially the aquatic ones) with a liberal supply of air-sacs. They are also provided with a

dense covering of feathers or down, which adds greatly to their bulk without materially increasing their weight. The air-sacs are well seen in the swan, goose, and duck; and I have in several instances carefully examined them with a view to determining their extent and function. They appear to me to be connected with the function of respiration, a view advocated by Hunter in 1774, and within the last year or so by Drosier, of Cambridge. That they have nothing whatever to do with flight is proved by the fact that some excellent flyers, take the bats, *e.g.*, are destitute of them, while the wingless running birds, such as the the ostrich and apteryx, which are incapable of flight, are provided with them. The same may be said of the hollow bones: some really admirable flyers, as the swallows, martins, and snipes, having their bones filled with medullary substance, while the bones of the running wingless birds alluded to are filled with air. Furthermore, and finally, a living bird weighing 10lbs. weighs the same when dead, minus a very few grains; and all know what effect a few grains of heated air would have in raising a weight of 10lbs. from the ground.

When we have said that cylinders and hollow chambers increase the area of the insect and bird, and that an insect and bird so constructed is stronger, weight for weight, than one composed of solid matter, we may dismiss the subject, flight being, as I shall endeavour to show by-and-by, not so much one of weight as of power properly directed, *i.e.* power directed on strictly mechanical principles. Those who subscribe to the heated-air theory are of opinion that the air contained in the cavities of insects and birds is so much lighter than the surrounding atmosphere, that it must of necessity contribute materially to flight; but the quantity of air imprisoned is, to begin with, so infinitesimally small and the difference in weight which it experiences by increase of temperature so inappreciable, that it ought not to be taken into account by anyone endeavouring to solve the difficult and important problem of flight. The Montgolfier or fire balloons were constructed on the heated-air principle; but as these have no analogue in nature and are apparently incapable of improvement, they need not detain us at this stage of the inquiry. The area of the insect and bird when the wings are fully expanded is, with the single exception of the bats, greater than that of any other class of animals, their weight being proportionally less. It ought, however, never to be forgotten that even the lightest insect or bird is immeasurably heavier than the air, and that there is no fixed relation between the weight of body and the expanse of wing in either class. We have thus light-bodied and large-winged insects and birds, as the butterfly, heron, and albatross: and others, whose bodies are comparatively heavy, while their wings are insignificantly small, as in the sphinx-moth and stag-beetle among insects, and the grebe, quail, and partridge among birds. Those apparent inconsistencies are readily explained by the greater muscular development of the heavy-bodied short-winged insects and birds, and the increased power and rapidity with which the wing is made to oscillate. This is of the utmost importance in the science of aerostatics, as showing that flight may be obtained by a heavy, powerful animal with comparatively small wings, as well as by a lighter one with enormously enlarged wings. While, therefore, there is apparently no correspondence between the area of the wing and the animal to be raised, there is an unvarying relation as to the weight and number of oscillations, so that the problem of flight seems to resolve itself into one of weight, power, velocity, and small surfaces, *versus* buoyancy, debility, diminished speed, and extensive surfaces: weight in either case being a *sine qua non*.

In order to utilize the air as a means of transit, the body in motion, whether it moves in virtue of the life it possesses, or because of a force superadded, must be heavier than it. If it were otherwise, if it were rescued from the operation of gravity on the one hand, and bereft of independent movement on the other, it must float about uncontrolled and uncontrollable, as happens in the ordinary gas balloon. The difference between an insect or bird and a balloon here insisted upon was, I have learned since writing the above, likewise pointed out by His Grace the Duke of Argyll, in his very able and eloquent article in "Good Words," entitled "The Reign of Law"—an article whose merits cannot be too widely acknowledged or too universally know. The wings of insects and birds are, as a rule, more or less triangular in shape, the base of the triangle being directed towards the body, the sides anteriorly and posteriorly. They are also conical on sections from within outwards and from before backwards, this shape converting the pinion into a delicately-graduated instrument, balanced with the utmost nicety to satisfy the requirements of the muscular system on the one hand, and the resistance and resiliency of the air on the other. While all wings are graduated as explained, innumerable varieties occur as to their general contour, some being falcated or scythe-like, others oblong, others rounded or circular, some lanciolate, and some linear.

Wing of Insect.—The wings of insects may consist either of one or two pairs; the anterior or upper pair, when two are present, being in some instances greatly modified and presenting a corneous condition. When so modified they cover the under wings when the insect is reposing, and have from this circumstance been named elytra from the Greek ἔλυτρον, a sheath. The elytra or wing-cases, as they are sometimes called, are dense, rigid, and opaque in the beetles; solid in one part and membraneous in another in the cockroaches; more or less membraneous throughout in the grasshoppers; and completely membraneous in the dragon-flies. The superior or upper wings are indirectly connected with flight in the beetles, cockroaches, and grasshoppers, and actively engaged in this function in the dragon-flies and and butterflies. The true wings, and by this I mean the membraneous ones, present different degrees of opacity; those of the moths and butterflies being non-transparent; those of the dragon-flies, bees, and common flies presenting a delicate, filmy, gossamer-like appearance. They have, however, this feature in common, and it is fundamental; both pairs are composed of a duplicature of integument, or investing membrane, and are strengthened in various directions by a system of hollow, horny tubes, known to entomologists as the neuræ or nervures. These nervures taper towards the extremity of the wing, and are strongest towards its root and interior margin, where they supply the place of the arm in bats and birds.

The neuræ are arranged at the axis of the wing after the manner of a fan or spiral stair; the anterior one occupying a higher position than that farther back, and so of the others. As this arrangement extends also to the margins, the wings are more or less twisted upon themselves, and present a certain degree of convexity on their superior or upper surface, and a corresponding concavity on their inferior or under surface; their free edges supplying these fine curves which act with such efficacy upon the air in obtaining the maximum of resistance and the minimum of displacement. As illustrative examples of the form of wing alluded to, that of the beetle, bee, and fly may be cited: the pinion in those insects acting as helices, or twisted levers and elevating weights, much greater than the area of the wing would seem to warrant. The insects adverted to fly, as a rule, with great accuracy and speed, and frequently in a straight line.

From the foregoing account it is evident that the wings of insects vary as regards their number, size, and shape. They also differ as regards their surfaces, margins, venation, degree of consistence and position, so that it might naturally be asked, Do the several orders of wings act according to a common principle, or does each wing act according to a principle of its own? There can, I think, be but one answer to this question. All wings obtain their leverage by presenting oblique surfaces to the air, the degree of obliquity gradually increasing in a direction from behind, forwards and downwards, during extension when the sudden or effective stroke is being given, and gradually decreasing in an opposite direction during flexion, or when the wing is being more slowly recovered preparatory to making a second stroke. The effective stroke in insects, and this holds true also of birds, is therefore delivered downwards and forwards, and not as the majority of writers believe, vertically, or even slightly backwards. This arises from the curious circumstance, that insects and birds when flying actually fall through the medium which elevates them, their course being indicated by the resultant of two forces, viz.: that of gravity, pulling vertically downwards, and that of the wing, acting at a given angle in an upward direction. The wing of the bird acts after the manner of a boy's kite, the only difference being that the kite is pulled forwards upon the wind by the string and the hand, whereas in the bird the wing is pushed forwards on the wind by the weight of the body and the life residing in the pinion itself. The angle at which the wing acts most efficaciously as an elevator, as proved by an examination of the pinion of the living insect, bat, and bird, when fully extended and ready to give the effective stroke, is an angle of 45° with the horizon. As, however, this angle could not be uniformly maintained without a rotatory motion which would wrench the wings from their fixings, a compromise is adopted, the wing being made to rotate on its axis to the extent of a quarter of a turn in one direction during extension, and the same amount in an opposite direction during flexion. That the wing rotates upon its axis as explained may be readily ascertained by watching the movement in the larger domestic fly. If the insect be contemplated either from above or beneath, the blur presented by the rapidly oscillating wing will be found to be concave, the depressed portion representing the wing, when its plane of least resistance is parallel with the plane of progression. Of this I have had the most convincing proof, particularly in semi-torpid insects where the wing was plied with less vigour than usual. To confer on the wing the multiplicity of movement which it requires, it is supplied with a double hinge or compound joint which enables it to move not only in an upward, downward, forward, and backward direction, but also at various intermediate degrees of obliquity. An insect furnished with wings thus hinged may, as far as steadiness of the body is concerned, be not inaptly compared to a compass set upon gimbals, where the universality of motion in one direction ensures comparative fixedness in another.

Many instances might be quoted of the marvellous powers of flight residing in insects as a class. The male of the silkworm moth (Attacus Paphia) is stated to travel more than 100 miles a day;* and an anonymous writer in "Nicholson's Journal" calculates that the common house-fly (Musca domesticus) in ordinary flight makes 600 strokes per second, and advances 25 feet; but that the rate of speed, if the insect be alarmed, may be increased six or seven fold, so that under certain circumstances it can outstrip the fleetest racehorse. Leuwenhoek relates a most exciting chase which he once beheld in a menagerie about 100ft. long, between a swallow and a dragon-fly (mordella). The insect flew with such incredible speed and wheeled with such address, that the swallow, notwithstanding its utmost efforts, completely failed to overtake it.†

Wing of Bird.—There are few things in nature more admirably constructed and where design can be more readily traced than in the wing of the bird. Its great strength and extreme lightness, the manner in which it closes up or folds during flexion, and opens out or expands during extension, as well as the method according to which the feathers are strung together, and slate each other in divers directions to produce at one time a solid resisting surface, and at another an interrupted and comparatively non-resisting one, present a degree of fitness to which the mind must necessarily revert with pleasure. The wing of the bird, like that of the insect, is concavo-convex, and more or less twisted upon itself when extended, so that the upper or thick margin of the pinion presents a different degree of curvature to that of the nether or thin margin: the curves of the two margins in some instances even intersecting each other. The twisting is in a great measure owing to the manner in which the bones of the wing are twisted upon themselves, and the spiral nature of their articular surfaces, the long axes of the joints always intersecting each other at right angles. As a result of this disposition of the articular surfaces the wing may be shot out or extended, and retracted or flexed in nearly the same plane, the bones composing the wing rotating on their axes during either movement. This secondary action, or the revolving of the component bones upon their own axes, is of the greatest importance in the movements of the wings, as it communicates to the hand and

* Linn. Trans. vii. 40.

† The hobby falcon, which abounds in Bulgaria, is equal to this task—the dragon-fly forming a principal constituent of its food.

fore-arm, and consequently to the primary and secondary feathers which they bear, the precise angles uecessary for flight. It, in fact, ensures that the wiug, and the eurtain or fringe of the wing, which the primary and secoudary feathers form, shall be screwed into and down upon the wind in extension, and unscrewed or withdrawn from the wind during flexion. The wing of the bird may, therefore, be compared to a huge gimlet or auger, the axis of the gimlet representing the bones of the wing, the flanges or spiral thread of the gimlet the primary and secondary feathers. As the degree of rotation made by the bones of the fore-arm and hand during extension amounts as nearly as may be to a quarter of a turn of a spiral, it follows that in flexion the wing presents a knife-like edge to the wind; whereas in extension of the wing is rotated in a downward direction until its anterior or concave surface makes an angle of 45° with the horizon. From this description it will be evident that by the mere rotation of the bones of the fore-arm and hand the maximum and minimum of resistance is secured much in the same way that this object is attained by the alternate dipping and feathering of au oar.

Balloon.—This, as my audience is aware, is constructed on the obvious principle that a machine lighter than the air must necessarily rise through it. The Montgolfier Brothers invented such a machine in 1782. Their balloon consisted of a paper globe or cylinder, the motive power being superheated air supplied by the burning of vine twigs under it. The Montgolfier, or fire-balloons, as they were called, were superseded by the hydrogen-gas balloon of MM. Charles and Robert, this being, in turn, supplanted by the ordinary gas balloon of Mr. Green. Since the introduction of coal gas in the place of hydrogen gas no radical improvement has been effected, all attempts at guiding balloons having signally failed. This arises from the vast extent of surface which they necessarily present, rendering them a fair conquest to every breeze that blows; and because the power which animates them is a mere lifting power which, in the abseuce of wind, must act in a vertical line, all other motion being extraneous aud foreign to it. It consequently rises through the air in opposition to the law of gravity, very much as a dead bird would fall in a dowuward direction in accordance with it. Having no hold upon the air, this cannot be employed as a fulcrum for regulating its movemeuts, and hence the cardinal difficulty in ballooning as an art.

Any one attempting to control the movements of a balloon is very much in the position of a boatman who endeavours to steer his craft, which is drifting with the current, by pushing against the stern.

If ever the balloon is to be utilised as a means of transit, this will probably be achieved by converting part of its lifting power into a horizontal propelling power, which possibly could be done by affixing a horizontal screw, like a small windmill, to the car; this apparatus receiving its motion by being forced against the air from beneath during its ascent (the air playing upon it frm above), and communicating its movements to a similar and smaller screw placed vertically or at right angles, which could be made to revolve with great celerity as a driving screw. To prevent rotation in the balloou itself, it might to be armed with plates of some light material placed at right angles to the plane of rotation. The great expense, however, involved in the construction and filling of the balloon will always operate against its being used otherwise than as a luxury; while the enormous expanse and delicacy of the material employed, as well as the chance in volume of the coutained gas arising from increase or decrease of temperature, cannot fail to prove troublesome, not to say dangerous.

Finding that no marked improvement has been made in the balloon since its introduction iu 1782, we natnrally turn our attention to some other method of traversing the air; and here I would add my indepeudent testimony in favour of the helix or screw, not only as a lifting power, but also as a propelling power. When I commenced my inquiries into the structure and uses of wings, I was early struck with the curious manner iu which they are twisted upon themselves, and how they are rotated on and off the wind during flexion and extension, after the manner of screws; and without kuowing (for the subject of artificial flight is not much in my way) that the helix had been proposed as a means for raising inanimate bodies, I had actually constructed a double screw, with a view to testing its efficacy in this respect.* I have therefore unwittingly laid anatomy and physiology under contribution in support of what I find is not a new doctrine.† I was impelled in this directiou by detecting the principle in nature, and from knowiug that a body to rise and progress in the air need not uecessarily be lighter than it; in fact, that the balloon is constructed on a principle diametrically opposed to that on which the bat, insect, and bird are constructed, and is from this circumstance open to serious, and in some respects, insuperable objections.

The efficacy of the screw in water is well known, and the action of the child's toy, usually called the spiralifer, will illustrate its utility as applied to the air. This toy, for toy it has hitherto heen, consists of two inclined planes, produced by simply twisting the enveloping wires iu opposite directions. It therefore represents the most primitive form of screw. This apparatus, simple as it may appear, curiously enough furnishes the mechanical appliauce by which a body is elevated, or elevated and carried in a horizontal direction at one and the same time. By applying the necessary power the spiralifer can be made to act vertically or horizontally, or at any intermediate angle, so that we have in it an easily regulated and perfect driviug power. The position taken up by the advocates of the screw is the reverse of that occupied by the advocates of the balloou; so that the aeronaut promises at no distant day to be fairly impaled on the horns of a dilemma, by having on the onehand, a motive power which (because of the space occupied by it) no human ingenuity can direct; and on the other hand a thoroughly manageable and docile elevating and driving apparatus, minus an adequate motive power. The problem of flight will probably be solved by one employing a certain proportion of gas to assist him in overcoming the inertia of his machine while he uses the screw as a propeller and partial elevator. Of the two systems propounded, if they be judged separately, I incline to that which proposes to employ the screw both in elevating and propelling, and this for two reasons: 1st, Because the screw or a modification of it is the instrument by which, as I have shown, the insect, bat, and bird rises and progresses; and 2nd, Because a certain degree of weight is necessary to overcome the air and make it useful for the purposes of aerostation.

That the principle of the helix as applied to the air is correct, is proved by the very remarkable experiments of MM. Pontiu d'Amécourt and De la Landelle, both of whom have constructed withiu the last three years helicopteric models, which not only rise by themselves into the air, but also carry graduated weights.* The difficulties therefore atteuding aerial locomotion by means of the screw are already partially surmounted.

The advantages which will accrue from the employment of the screw in aerostation may be briefly stated.

It occupies little space, is strong without being heavy, and is prodigiously powerful.

It rigidly economises the motive power by keeping the inclined planes of which it is composed closely applied to the air throughout its entire revolution.

The speed of the screw can be increased at pleasure—increased velocity, as I have shown iu the insect and bird, conferring enormously increased propelling and lifting power.

By a judicious combination of horizontal, vertical, and oblique screws, almost any degree of speed may be attained, and any course, whether upwards, downwards, or forwards, pursued.

A machine elevated and propelled by screws will be necessarily a compact machine—a machine which will navigate the air as a master; its weight and the small surface occupied by it rendering it superior even to moderately high winds.

The nearer such machine is kept to the earth and the greater the density of the atmosphere, the greater will be its facility and power—the inconveuiences arising from temperature and excessively rarefied air being thus avoided.

The aerial screw machine should be coustructed whenever practicable of hollow cylinders fixed into a floor, composed of one or more flattened cylindroid chambers filled with hydrogen or other gas to diminish weight. The flattened cyliuders, if laid horizontally or inclined in a slightly upward direction, would act mechanically as sustainers and gliders, as do the wings in sailing and gliding birds. It is just possible that the motive power required for the helicopteric flying-machine may be derived from compressed atmosphere, the air being compressed by the aid of au engine on *terra firma*, and stowed away in the cylinders comprising the floor or other portions of the machine before starting.

When and where such a machine will be successfully launched no one can of course predict. The subject of artificial flight, however, has been so frequently discussed of late years, and has excited so much interest in America, France, and other portions of the Old and New World, that it must obviously receive a settlement in one direction or other at uo distant date. Even Britain, iuvolved as she is in business and politics, and caring little about science which is not directly remunerative, has made a move in this directiou, and we have now the "Aeronautical Society of Great Britaiu," presided over by His Grace the Duke of Argyll, himself a Goliath in aeronautical matters. It were much to be desired that those who can afford the time or the means requisite for conductiug experiments on a scale commensurate with the importance of the subject, would lend their aid to this great public movement.

Homo Volans.—Whether the *genus homo* will ever be able, by his unaided exertions, to leave the scene of his joys and sorrows for the fields etherean, time ouly can determine. Borelli, a great anatomical authority,† made elaborate calculations to prove the absurdity of such au attempt. His calculations, however, will not deter the more sanguine and speculative portions of mankind from renewing their exertions iu this direction as opportunity permits; aud I may state, for their guidance iu the matter, that if man ever flies it will not be by employing his arms simply, but by concentrating the euergies of his entire muscular system—by transferring iu fact the movements of his arms and legs to a central axis or shaft, surmounted by one or more horizontal and vertical screws of appropriate size and shape; these being made to revolve with a velocity to be determined by experiment. The value of this hypothesis could be readily tested, and at a trifling expense, by a machine constructed after the mauner of a velocipede, which need not be of a very complicated character.

In order to construct a successful flying machine, it is not necessary to imitate the filmy wing of the insect, the silken piuion of the bat, or the complicated and highly differential wing of the bird, where every feather may be said to have a peculiar function assigned to it; neither is it necessary to reproduce the intricacy of that machinery by which the pinion in the bat, insect, and bird is moved: all that is required is to distinguish the form and exteut of the surfaces and the mauner of their application, aud this has, in a great measure, been already done. When Vivian aud Trevithick constructed the locomotive, and Symingtou aud Bell the steamboat, they did not seek to reproduce a quadruped or a fish; they simply aimed at producing motiou adapted to the land aud water in accordauce with natural laws, and in the presence of living models. Their success is to be measured by an involved labyrinth of railroad which extends to every part of the civilised world, aud by navies whose vessels are despatched without the slightest trepidation to navigate the most boisterous seas at the most inclement seasons. The aeronaut has the same task before him in a different direction, and in attempting to produce a flyiug-machiue he is not uecessarily attempting an impossible thing. The countless swarms of flying things testify as to the practicability of the scheme, aud nature at once supplies him with models and

* This screw had four fans or blades, two of which revolved from left to right; the remaining two from right to left. This I found to be necessary to prevent rotation in the driving apparatus, which consisted of a steel spring and clockwork.

† Paucton, the engineer, predicted the future importance of the screw in aerial navigation, as early as 1768.

* Extract from a paper by Mr. Nadar, 1863, quoted iu "Astra Castra," by Hatton Turner, London, 1865, page 340.

† De Motu Animalium.

materials. If artificial flight were not attainable, the insects and birds would afford the only examples of animals whose movements could not be produced. The outgoings and incomings of the quadruped and fish are, however, already successfully imitated, and the fowls of the air, though clamourous and shy, are not necessarily beyond our reach. Much has been said and done in clearing the forest and fertilising the prairie, can nothing be done in reclaiming the boundless regions of the air?

INSTITUTION OF NAVAL ARCHITECTS.

The eight annual meeting of the Institution or Naval Architects commenced on April 11th, at the Society of Arts, Sir J. S. Pakington, M.P., President, in the chair.

The annual report of the Council having been read by Mr. Merrifield, Sir J. S. Pakington proceeded to deliver the following

President's Address.

Gentlemen,—I cannot open this session of this admirable Institution for the year 1867, having, as I have, the honour of being your president, without expressing the great and sincere satisfaction which it gives me to meet you again, and also the satisfaction with which I see upon this occasion, as I have upon many former occasions, a very large and numerous attendance of those able and scientific men who take an interest in the prosperity and the progress of this Institution. But, gentlemen, there is one serious drawback to the pleasure which I feel in again filling this chair, and that is, that whilst on former occasions I have always been obliged to offer to you some apology, or to request your indulgence, on account of the extent to which, from Parliamentary duties, I was obliged to absent myself from the meetings of this society, on the present occasion, from the heavy official duties in which I am engaged, I am sorry to say I must trust to your kindness and indulgence to allow me, I am afraid, to be absent from the greater part of your proceedings. Indeed, gentlemen, I am so situated this morning that I am now interfering in the prescribed order of our proceedings. You will see in the programme of proceedings the next item of business after the report of the council, which you have just heard, is that the special report of the council on the Safety of Iron Ships ought now to be read to you; but really my time is so limited that I am obliged, I am sorry to say, to request your permission so soon to retire from the room, that I beg to take the liberty of offering to you the few observations which I desire to make before the report of the council it read. Gentlemen, with regard to the contents of the report which you have just had read, I am happy to say that now, as on previous occasions, I can only address you in that language of congratulation which the council have adopted with regard to tho continuous, prosperous, and successful action, and, I think I may say, the general prosperity of this Institution. There is, I regret to add, a paragraph in this report adverting in somewhat unfavourable terms to the financial position of the Institution; but I am happy to add that this has become the subject of conversation this morning at a preliminary meeting of the council, I am happy also to say that, although the state of our finances is not so prosperous as the friends of the Institution could desire, still there is nothing at all to forbid the confident hope that financial prosperity may be entirely restored, and that no impediment of that sort may, for the future, impede or affect the utility and the prosperous action of this society. Those who are members of the Institution have probably received the seventh report, which has been recently published, and, therefore, it is hardly necessary for me to advert to the valuable nature of that report, and especially to the fact that it contains a very complete index of all our former reports, and I probably should not have thought it worth while to occupy time by any reference to that report, were it not for the acknowledgment which I think is due from every member and every friend of this Institution for the great ability and the labourious zeal with which our secretary, Mr. Merrifield, has prepared that index which we find so useful. Gentlemen, there is another topic touched upon in this report which is of immediate importance at all events to the comfort and the means of action of this society. I allude to the fact that we are likely very soon to be obliged to leave the offices in Adelphi-terrace which have been so long occupied by the Institution, and partly with the view to perhaps increased accommodation, and partly with the view, it must be acknowledged, to financial considerations, it has become a question with the council whether or not this valuable Institution, which is acquiring year by year greater national importance, has not a fair claim to receive from the Government accommodation in some of the Government establishments. This suggestion has been offered by the council, and I felt it my duty, in consequence of that suggestion, to communicate with the Duke of Marlborough, as Lord President of the Council, to ask his Grace whether in his opinion there were any apartments in any of the Government establishments which could, as a temporary arrangement at all events, be occupied by this society. I am very sorry to say I have received from his Grace an unfavourable answer. He has taken it into very full and very friendly consideration, and I have received from him a letter to say that neither at South Kensington (and, perhaps, it would be somewhat doubtful whether, even if we could get permission to go to South Kensington, it would be a convenient situation, considering the distance), nor elsewhere, can we be accommodated. I am extremely sorry to say that at the present moment I have not received from the Lord President any encouraging answer to the application which I conveyed from the council for accommodation in any of the Government establishments. It, therefore, will be necessary, upon the expiration of our term in Adelphi-terrace, which will take place in two or three months from this time, that we should look out for our apartments elsewhere. It has been suggested to me that, perhaps, at Somerset House, under some new arrangement hereafter, accommodation might be given to us. At all events, at present Somerset House is fully occupied, and, I believe, there is no chance of our receiving accommodation there within any early period. Therefore I would suggest to the meeting, and I think it is a question for the grave consideration of the council, whether or not it may not be, at least, worth while—I speak now with perfect freedom from any connection with the Admiralty—but I would throw out whether it might not be worth while, considering the important national objects that are carried out by this Institution, to make an application to the Admiralty, and whether or not we might not be considered entitled to an annual grant to assist us in the national objects which we carry out. It must be well known to those who I am now addressing that in the case of the United Service Institution—no doubt a most valuable institution—both from the War Department and the Admiralty pecuniary assistance is given to carry out the affairs of that institution. Of course this Institution could establish no claim to assistance from the War Department, but I think we might establish a claim which, so far as our finances are not prosperous, might be considered as unanswerable, to have assistance from the Board of Admiralty. At all events, I think it would be worth while for the council, under the circumstances I have adverted to, to make an application of the character to which I have alluded. Gentlemen, I will now advert for a moment to that which certainly has been by far the most important action of this Institution during the year that has elapsed since I had last the honour of meeting you in this chair. It must be, I think, in your recollection that at the time when we met last year, which was somewhat earlier than it is now, the minds of the public were painfully occupied by the dreadful catastrophe which had just occurred in the Bay of Biscay in the loss of the *London* passenger ship. It may be in your recollection that I thought it my duty, in the opening address which I delivered at our last annual meeting, to call the attention of this society to that dreadful event, and to point out to them the opinion that I ventured to entertain, that it would be hardly possible for the able and scientific members of this Institution to address themselves to any question more appropriate to the objects for which we have been called into existence, than to inquire whether or not that dreadful catastrophe, accompanied, as it was, by not a few similar accidents about the same time, was or was not to be traced to any defect either in the architectural skill with which our passenger ships are constructed, or to any defect in our laws with regard to the protection of that most important, but quite helpless, portion of our fellow-subjects, who are called upon and compelled by their duties and vocations in life to cross the seas, and to become passengers in those ships. The suggestion which I ventured to offer was warmly responded to by the meeting which I had the honour to address, and before the close of our proceedings a motion was made—I think by my friend Mr. Reed, and seconded by Mr. Scott Russell—that the council should devote their serious attention to the question which I had taken the liberty of suggesting. I am happy to inform you, gentlemen, that that part of our proceedings last year has been most satisfactory in its nature, and most honourable to the members of this Institution. The council undertook what certainly has proved a very laborious and a very arduous duty. They commenced their proceedings, if I remember rightly, about the month of May. My many avocations rendered it impossible for me to do that which I would gladly, though perhaps uselessly, have done, namely, attend those meetings; therefore, I am the more free to speak of the view I entertain of the manner in which those proceedings were conducted. Under the able presidency of our distinguished friend, Sir Edward Belcher, the council met on no less than fourteen different occasions, and in the course of those fourteen sittings they entered in the most close, and able, and satisfactory manner into this most interesting question which has been referred to. Their report was drawn up towards the close of last year. That report, as I have stated, if it had not been for the unfortunate pressure on my own time, would already have been read to you. But, gentlemen, it will be read to you as the next proceeding in the business of this morning, and I am confident it must impress the mind of every one who hears it, with a deep sense of the great ability and great zeal with which that inquiry has been conducted.

I hope and believe that the Institution will attach very great importance to the series of, I think, fifteen suggestions which that report embodies. I think also that I ought to add that it is, I believe, the unanimous feeling of the council that in addition to the suggestions which they have embodied in their report, and which, of course, from the nature of this Institution, relate mainly, if not solely, to the question of the construction of our ships, but I believe I may say it is their unanimous opinion that it would be a very desirable that the many remaining questions of a different nature as affecting our laws for the protection of passengers, should become the subject of inquiry by a Royal Commission. With this view a deputation from the council did me the honour to request an interview with me upon the subject of their report. That interview took place only a few days ago. At my request the Duke of Richmond, as President of the Board of Trade, did us the favour to join me in receiving that deputation. A more interesting deputation I think I never listened to. It was composed of men most eminent for their acquirements on this subject. The Duke of Richmond was deeply struck with the whole of our conversation. What may be the ultimate decision of the Government I am at present unable to say; but certainly the question will be taken into consideration by the Government, whether or not the state of our laws upon this interesting subject is not so for unsatisfactory and incomplete as to make it desirable that the inquiry by a Royal Commission should be added to that inquiry by the council of this Institution, which has been already so ably and so completely conducted. I do not think I need detain you by making any further remarks on this subject, important as it is. But, gentlemen, there is another subject, by no means a new one, but which is still of the greatest importance; and I will advert to it for a moment, mainly because I am happy to say I can do so with terms of increasing satisfaction. I allude to the continued and successful progress of that School of Naval Architecture, the existence of which is mainly to be attributed to the persevering and zealous exertions of this Institution. I am happy to say that every report which I hear of the progress of that School of Naval Architecture is satisfactory, with this exception, that I wish I could hear of a larger proportion of private pupils connected with our own country. At present a very considerable majority of the pupils in the School of Naval Architecture are those supplied by the Admiralty, and I am informed that many of those that come under the definition of private pupils are foreigners. I think it is a matter of pride and satisfactory reflection that our school should already have attracted so much notice and inspired so much confidence, that foreigners find it worth their while to come to England to study in that school; and I have no doubt, from the number of Government pupils, great impulse has been given to the study of this most important science of naval architecture, and we shall find among the private pupils there will be no inconsiderable supply of competent men added to this profession. But I confess I should be glad to hear, in the first place, that the number of private pupils was increased, and secondly, that the preparation of those private pupils in the study of mathematics was somewhat more satisfactory upon the commencement of their career in the School of Naval Architecture than I am led to suppose at present it is. Gentlemen, I think those subjects of great national interest which have led to the state of transition in which the construction of men-of-war has existed for the last few years. But I think that question of transition is less pressing than it was a short time since. Years have passed away, and a great revolution in the construction of our ships has taken place. Amongst the various questions still remaining, the only one I think I can now speak of as one of very pressing interest, is that question which still certainly remains an unsettled question—I mean the question between the turret system and the broadside system. When I have had the pleasure of addressing you on former occasions, I have thought it my duty, more or less, to touch on this question, and I did so last year; but I think I may now speak of that question as being so far in a satisfactory state that it is in a fair way to practical solution. On former occasions I have felt it my duty to express my regret that the Board of Admiralty—of course speaking here, as I am sure you will fully believe, with no party feeling, and in no party sense—but I have felt it my duty, in the public interest, to express my regret that, for a considerable period, the late Board of Admiralty, whilst recognising the importance of the suggestion of the turret, had not taken adequate steps to carry that question to the state of practical experiment. No further complaints of this kind can exist. The late Board of Admiralty (and I entirely give the credit to the late Board of Admiralty)—not so soon as we might have wished—but they eventually did take those steps which I think the public interest and the public voice required, and lately they decided on the commencement of two ships which involved this experiment to its fullest extent, and by which I hope this great experiment and problem will be fairly solved. I allude to the *Monarch*, which I think was designed by my friend Mr. Reed, and with respect to which ship Captain Coles received from the late Board, and still more from the present Board (for the matter was not quite commenced when the late Board went out) *carte blanche* to construct that ship according to what his own views of its construction might be. So that I am happy to say, so far as regards those two ships, that great and important question which has so far divided the nautical world, is in course of fair solution, and we must await the trial of those experiments upon a question which I cannot conclude my remarks without adding, is a question open to very serious doubt. Gentlemen, I do not remember at this moment any further questions upon which I should desire to touch. I think I may say, echoing, I believe, the opinion of one of our most important members, that if this Institution of Naval Architects were now to vanish from the scene, and this were to be, which I hope is very far from being the case, our last assembly, I think those gentlemen who promoted the establishment of this Institution might well reflect with pride upon the course they took, and with a conviction that this Institution had conferred great public benefits, if it were only in the recollection of the two subjects to which I have adverted to-day—first, the establishment of the School of Naval Architecture; and, secondly, that inquiry which has been conducted with so much ability and so much zeal throughout the past year, into the construction of those ships which convey our countrymen by sea. Those are the two great subjects. I think I may say those are two great acts, and I cannot close my reference to the last of them, namely, the inquiry into the construction and safety of iron mercantile ships, without expressing—and I hope in doing so I am expressing the sense of every one that hears me—my warm acknowledgment and hearty gratitude to the able gentlemen who have so well conducted that inquiry. With regard to the future action of the society, so far from any idea of its vanishing from the scene, I confess I, in a sanguine spirit, anticipate for it a career of continual prosperity. Fresh arrangements have lately been made, and they are of the most promising nature. I am very happy indeed to be able to say that notwithstanding his official avocations and exertions, and the great calls upon his time, which, of course, must be the consequence of his position, Mr. Reed has again joined the active members of this society. We are now in the position of having an executive committee consisting of three gentlemen whose competence will be universally acknowledged, namely, Mr. Scott Russell, Mr. Reed, and Mr. Ritchie; and to the very great advantage of this society, and in a manner which demands our warmest acknowledgment, I am happy to say that Mr. Merrifield has given gratuitously his services as the honourary secretary of this Institution. Aided as they are by the zealous assistance of Mr. Campbell, I think I am justified in the hope, with the expression of which hope I will conclude these observations, that through many future years we may look forward to a constant increase of prosperous and successful action, and that year by year this Institution will be more and more recognised as conferring great and important advantages on the country.

Report of the Council on the Safety of Ships.

At the close of the meeting of the society in 1866, the following resolution was adopted unanimously :—

"That in the opinion of the members and associates of this Institution, it is desirable that an early meeting of the council take place, for the purpose of considering, with reference to the President's opening speech, and the papers that have been read on the security of iron ships, what recommendations could best be offered to the public, in order to prevent, as far as possible, the loss of passenger and other vessels."

In accordance with this resolution, the council have given careful consideration to the question of the safety of iron ships, all the members of the council having been consulted at each stage of the proceedings. The council have ultimately arrived at the following conclusions, and offer them, with such recommendations as they contain, to the profession, in the hope that they may be adopted by shipowners and builders, and may tend to increase the safety of passenger and other vessels:—

1. No general rule can be safely laid down for regulating the proportions of length and depth to the breadth of a ship, and a great variety of proportions of length and depth to breadth may be safely adopted, and the ship made sound and seaworthy by judicious form, construction, and lading.

2. The construction load water-line of every ship, and her scale of displacement from light to load water-line, should be appended to every design of a ship, showing the extreme draught to which she should be laden, and measures should be taken to ensure that this information be recorded on the ship's papers. It is desirable also that, along with the ship's papers, in the possession of the captain, there should always be carried a scale of displacement, a sail draught, and a set of outline plans of the ship, comprising a longitudinal section, and at least four cross sections of the ship. On these plans should be marked the capacity, in tons of 40 cubic feet, of each compartment of the hold. The surplus buoyancy of each compartment up to the load water-line, or its power to carry dead weight, should be given in tons dead weight. These papers should always accompany the ship's register, and a copy of them should be lodged in the Custom-house of the port from which the ship hails.

3. There is a minimum height of freeboard which cannot be safely

reduced in sea-going ships of ordinary fitment, and it is desirable to fix this minimum height. Freeboard should be understood to be the vertical height of the upper surface of the upper deck (not spar-deck), at the side, amidships, above the load water-line. The proportion of freeboard should increase with the length. One-eighth of the beam is a minimum freeboard for ordinary sea-going ships of not more than five breadths to the length, and $\frac{1}{32}$ of the beam should further be added to the freeboard for each additional breadth in the length of the ship. This would give:—

For a ship of 32ft. beam and 160ft. long, 4ft. freeboard.

For a height of 192ft., 5ft. freeboard.

For a length of 224ft., 6ft. freeboard.

For a length of 256ft., 7ft. freeboard, the beam remaining the same; but as the addition of a spar-deck on long vessels may be considered an equivalent or substitute for the increased freeboard required for extra length, a complete spar-deck would leave the freeboard of these extra lengths at the original height of 4ft.

4. It is not considered desirable to offer any recommendations with regard to poops and forecastles. It must depend entirely upon the prafessional judgment of the designer of a ship, whether, looking to her proportions, form, and purpose, the additions of poop and forecastle are expedient and safe. In general, where poops and forecastles are adopted, they should be closed and seaworthy, but their weight may be inexpedient in long fine ships; and there are cases where a light top-gallant forecastle (*i.e.*, an open forecastle raised above the level of the upper deck) may be useful in keeping heavy seas out of the ship. In general, spar-decks in long ships are preferable to poop and forecastle, and no diminution of freeboard should be allowed for a poop or forecrstle.

5. It would add much to the strength and security of steamships if transverse and longitudinal bulkheads, coal bunkers, iron lower decks, and screw alley were all so connected with the hull of the ship and with each other, as to form independent cellular compartments, water-tight, and having all their communications with the decks and each other by water-tight doors worked from the deck. In proportioning the compartments of a ship (and especially of ships devoted to passengers) it is very desirable so to arrange them that if any *two* adjacent compartments be filled, or placed in free communication with the sea, the remaining compartments will float the ship. It is considered that no iron passenger ship is well constructed, unless her compartments be so proportioned that she would float safely were any *one* of them to fill with water, or be placed in free communication with the sea. Double bottoms are to be regarded as a great element, both of safety and strength, in the structure of a large iron hip.

6. It is very desirable that sufficient ventilation should always be provided in passenger ships, to admit of closing all side scuttles and battering down or otherwise enclosing all hatches in bad weather.

7. In regard to hatchways and openings in the deck, no limits can be set to their size; but it is desirable to carry the beams of the ship across them without interruption, wherever practicable; the beams may also be made removable where required, being replaced on going to sea. All coamings over engine and boiler rooms in passenger ships should be as high as practicable, of iron, and rivetted to the beams and carlings. Openings in the deck may be fitted with solid coverings, hinged in place so as to be readily closed.

8. It being considered that all openings in the sides or ends of vessels are subject to accidents that endanger the safety of ships, it is desirable that the side and stern windows should, in addition to the glass lights, have *hinged dead lights*, with a view to their being always in place; and that all cargo ports should be strongly secured by iron crossbars.

9. It is believed that all openings from and communications with the sea from engine room and pipes should be protected by conical, or Kingston, or sluice valves; and similar precautions should be taken for all openings through the bottom of the ship, where damage to pipes or ship would admit water into tbe holds.

10. It is considered that all steam vessels, if of iron, should have a brass-barrelled hand-pump to every compartment, except the forward and after ones, the former to have a sluice cock, or that, as a substitute for these pumps, there should be patent pumps, having independent connections to this extent. They should also have a donkey-engine and pump capable of pumping from the bilge and from the sea, of feeding the boilers, and of throwing water on deck. All vessels should have one or more bilge pumps, worked by the large engines, with bilge injection pipes if the engines have condensers. In large vessels the donkey-engines should have a separate boiler high above the water-line, and also communication with the main boilers. All vessels should have a set of bilge pipes connecting every hold and the engine compartments with these pumps. As a security against fire there should be pumps on the upper deck, fitted as force-pumps, and provided with a sufficient length of hose (with the necessary copper delivery jets) to reach either extremity of the vessel, and also provided with suction hose or pipes from the sea. The cocks, by which the working of the pumps is regulated, should be carefully arranged and marked, and great care should be taken that both cocks and pipes are accessible. A plan of the whole should accompany the ship's papers, and the crew should be periodically exercised in their use.

11. The stowage of a ship, whether done by contract or not, should be done under inspection of the captain of the ship, and should be conducted under his own orders only; and he alone should be held responsible for the good stowage of his ship. Ships are often very badly stowed, the weights being sometimes too low, thus causing them to roll with such rapid and violent motions as to carry away the spars, and otherwise endanger the safety of the ship; and, at other times, too high, thus making the ships crank, and liable to turn over. A ship may, however, generally, whatever her form, be so stowed as to avoid both dangers. As the character of the ship in these respects varies, so does the number of oscillations she would make per minute, if she were set rolling in still water, by men running across her deck, or other means, and then allowed to come to rest; that is, if the ship be crank, the number of oscillations per minute will be few, and if she be too stiff, they will be numerous; but under the same conditions of stowage the numbers will be always very nearly the same, whatever the amount of the impulse to set her rolling may be. Although this peculiarity has long been known to scientific men, no such observations have been made in merchant ships as would justify any specific rule on the subject. It is, however, most desirable that information should be collected upon it, and that the attention of the owners and captains of vessels should be called to it.

12. It is believed that the present rules of the Board of Trade regarding boats, life-boats, and their tackle, are good in principle. The responsibility for keeping all boats in constant readiness and efficiency obviously rests on the captain, and must fix on him the blame for all neglect and its consequences. Every open boat built of iron or steel should be fitted with sufficient water-tight spaces to float her.

13. The system of proportioning anchors and cables by Lloyd's, and of proving under license of the Board of Trade by Act of Parliament, is so far satisfactory; but as the proof-test alone cannot establish the excellence of the cable, the reputation of the makers must be relied upon.

14. In order to provide for the rapid clearance of the upper deck from water which may break over the ship, flap-boards should be fitted to the lower part of the bulwarks, sufficient in number and in area to admit of the rapid escape of the water.

15. Water-closets on decks below or near the water-line may be the means of gradually and imperceptibly flooding the ship, and endangering her safety, unless the pipes and valves are strong, and are carefully fitted.

In addition to the foregoing, the council desire to record various recommendations of members, which appear to them to be deserving of consideration, but which have not been embodied therein.

That the course adopted in ocean mail steamers under Admiralty survey is desirable in all ocean steamers, viz., that there should be two hawse pipes fitted on each bow, and a second pair of riding bitts, so as not only to provide means for readily letting go and riding by a third anchor, but also to have a spare hawse-hole and bitt on each side, in the event of either of the working hawse-pipes or bitts breaking, or becoming unserviceable.

That on the beams of each compartment should be painted the whole tonnage of the vessel, and the capacity of the particular compartment in tons of forty cubic feet, and that the dead weight and measurement tonnage in each such compartment should be shown on the ship's register before clearance.

That no dead weight should be permitted in either the fore or after sections of any passenger ship.

That all communications with the sea shonld be fully exposed to view, and be readily accessible to the engineers.

In the absence of any spar-deck, the engine hatchway should have coamings or water-tight bulkheads round it, rising at least as high as the bulwarks.

Certain portions of the ship, as for example the screw alley, might be made accessible for repairs after they had been bilged, by forcing air into them, and thus expelling the water, and such portions should be made air-tight, and be in communication with force pumps with a view to this.

Spars and boats should be so disposed as to float off in the event of a wreck and form a substantial raft. Deck houses and other portions of the ship may also be so fitted as to be readily detached from the ship as rafts.

In the discussion which followed the reading of this report, Messrs. Scott Russell, Grantham and Reed, spoke in favour of its adoption, while Mr. Wigram dissented. Finally, the motion put from the chair, "that the report be received" was carried unanimously.

Apparent Negative Slip.

By Professor W. J. Macquorn Rankine.

1. When the attempt has been made to account for the apparent negative slip of a screw propeller by the fact of its laying hold of a current of water that is following the ship, this objection has been raised: that the forward momentum impressed on that current in a second is equivalent to the resistance of the ship; that the backward momentum impressed by the screw on the propeller race in a second is equivalent to the thrust of the screw, which is equal and opposite to the resistance of the ship; and that, consequently, even if the screw were to take hold of every particle of the following current, that fact would account for a diminution of positive slip only, but not for negative slip. That objection is fully stated in the paper read last year by Mr. Reed, Chief Constructor of the Royal Navy.

2. If the velocity of the following current, in which the screw worked, were simply the mean forward velocity of the ship's wake, the objection in question would be unanswerable; for it is the momentum per second due to that mean velocity which is equivalent to the resistance of the ship, and to which the reasoning just mentioned applies.

3. But the water affected by the passage of the ship through it has various reciprocating or wave-like motions combined with the mean velocity of the wake; and, in particular, there is forward motion under every crest, and backward motion under every hollow of the waves that accompany the ship. The velocity of those reciprocating motions is not connected directly with the resistance of the vessel—in fact, their resultant momentum is equal to nothing; and it is only the momentum of the uniform current which remains after the wave-motions have died out, that is equivalent to the ship's resistance.

4. Hence, if there happens to be, as there generally is, the crest of a following or filling wave under the ship's counter, the water, of which the screw lays hold, has a temporary forward velocity over and above the permanent velocity of the wake; that temporary forward velocity, indeed, may be many times greater than the permanent velocity of that current whose momentum is equivalent to the resistance of the ship; and thus any extent of apparent negative slip may be accounted for.

5. The existence of a following wave explains also the fact that any considerable apparent negative slip is always accompanied by waste of motive power, the resistance to the motion of the engine increasing in a greater proportion than its speed is diminished. For amongst the laws of wave motion are the following: that all forward motion of the particles in a wave is accompanied by an elevation of level, and that the pressure against a body in front of the wave, due to that elevation of level, is exactly equal to the pressure required to impress the forward motion upon the particles of water. Such is the pressure exerted upon the stern of the ship by the wave which follows under her counter, when that wave is undisturbed by the action of the screw. But the screw, by checking or reversing the motion of the particles of water, lowers the level of the crest of the following wave, and diminishes the forward pressure which that wave exerts on the vessel. That diminution of pressure is virtually equivalent to an increase of the ship's resistance; so that the thrust of the screw must be equal not merely to the resistance properly due to the dimensions and figure of the ship, but to that resistance increased by a force equal to the diminution which the action of the screw produces in the pressure exerted on the ship by the following wave. Thus the total thrust of the screw is increased above its effective thrust—that is, above the proper resistance of the ship, in a proportion greater than the proportion in which the speed of the screw is diminished through apparent negative slip, so that the result is an increased expenditure of motive power above what would be required if the screw acted in water not affected by wave motion.*

6. The principles of the preceding paragraph do not apply to uniform forward motion of the particles of water produced by friction, because such motion is not accompanied by the production of a swell, and hence (as Mr. Froude has pointed out), the permanent following current in the ship's wake due to frictional resistance does not give rise to a loss of thrust, as the wave-motion of the particles of water does.

* See a paper on the Mechanical Principles of the Action of Propellers, "Transactions of the Institution of Naval Architects," 1865, vol. vi.

ON VAST SINKINGS OF LAND ON THE NORTHERLY AND WESTERLY COASTS OF FRANCE AND SOUTH WESTERN COAST OF ENGLAND, WITHIN THE HISTORICAL PERIOD.

By R. A. Peacock, C.E., Jersey.

(*Continued from page* 81.)

Dr. Barham quotes from the Saxon chronicle the particulars of the inundation of Nov. 11th, 1099; and of another on the same authority, in 1014:—"This year (1014) on Michaelmas eve, Sept. 28th, came the great sea-flood, which spread over this land, and ran up as far as it never did before overwhelming many towns, and an innumerable multitude of people." Now astronomers inform us, that about the year 1250 the sun was at its nearest to the earth on the shortest day,* and the natural consequences would be (and was historically) that the Swiss glaciers were then exposed to greater heat than any other which they have experienced during the Christian period, and consequently the greatest melting of ice took place then.† But this circumstance had nothing to do with the natural height of the tides, and even if it had had to do with them in 1250, that, of course, would not have accounted for unusually high tides on September 28th, 1014, or on November 11th, 1099, nor could there have been equinoctial tides at either of those dates. We cannot get rid of these catastrophes either, by refusing to believe them merely because they do not agree with this or that theory. No other course is open to us I submit, except to explain the immense destruction of towns and people by accepting as a fact, that the ground sunk at those dates. I propose to call it a *sinking* for the future.

He says that an argument for recent changes in the Mount has been found in a charter of King Edward the Confessor, in which St. Michael is spoken of as being *juxta mare*, and that he has seen this translated *near the sea*, but he submits that a more correct rendering would be, *by the sea*, a phrase he thinks sufficiently descriptive of its present situation. Now, on the contrary, I contend that the translation *near the sea* is the correct one; if the Mount had then been insulated, the correct expression would have been *in* or *on* the sea.—See Littleton's Latin Dictionary and Riddle's Dictionary.

In order to account for the submarine trees in Mount's Bay, Dr. Barham has recourse to "the low district" theory, but, unfortunately, this district like, that of Guernsey, (Art. 11) would have inevitably filled with water in less than eighteen months, so as to become a lake, which would have rendered it impossible for the trees to grow where they really did grow. "I suppose," he says, "that the lowlands extended about half a mile further towards the sea than they do now, and were there defended from this dangerous neighbour by a ridge of higher land, the situation of which is now indicated by the Long Rocks and others thereabout." Now this mention of the Long Rocks fixes the position of his supposed low district. They are shore rocks between Marazion and Penzance, and the Ordnance map shows that the low district can only have been of trifling extent, namely three quarters of a mile long by half a mile broad; and there is a brook draining 925 acres of land (including the low district itself) which falls into the sea at Long Rocks, which would of course have flowed day and night from year end to year end, into the supposed low district. Let us suppose the average annual rainfall to be 30in., which is little enough, for Cornwall is a rainy country by reason of its hills intercepting the rain clouds as they drift up from the Atlantic. We must, therefore, take about 16in. in depth as the annual "flow" off the land, as explained in Art. 11, both Guernsey and Cornwall consisting of igneous rocks. This would give a supply, in less than eighteen months, which would have filled the low district to overflowing, supposing it to have averaged 7½ft. deep, and then the surplus would have flowed over the lowest part of the "ridge," this lake would, of course, have prevented the trees from ever growing. It is submitted, therefore, that the low district theory must be abandoned. To account for the many other instances of submarine trees, which will be presently proved to exist, on the south-western coasts, I suppose Dr. Barham would have proposed many more low districts, which must now also be abandoned.

Though Dr. Barham admits "encroachments" of the sea, quoting the Rev. W. Borlase's statement (Art. 133), and two submersions in the years 1014 and 1099, he yet uses the following inadmissible argument in the form of a question. "It is admitted," he says, "that the Mount has been pretty much what it is for at least 800 years [No]; what hinders, then, but that it may just as likely have maintained‡ its ground for 2,000 years, or even a longer period?" I answer, that "Domesday Book" proves that it has *not* maintained its ground for 800 years; and to contend that it did so for the previous 1,100 years, is simply begging the question now debated. In truth, Dr. Barham had not the advantage of considering the effect of Ptolemy's positions of places, nor of "Domesday Book," nor of the many classical, middle age, and modern authorities as to the sinkings of land on the French coasts, which have been laid before the reader. Dr. Barham quotes Morery's Dictionary as to the former existence of a forest round Mont S. Michel, which he disbelieves. This disbelief would have been reasonable enough if the statement as to the existence of the forest had not been, as it is, abundantly corroborated. He did not know that sinkings of land have been the rule, and not the exception, all along the French coasts, and that the like may therefore be true of the Cornish coast opposite. In short, he has not accepted the great axiom that all geological effects, such as

* "Outlines of Astronomy," 1864, Art. 369b.
† Principles of Geology, 1867, p. 278.
‡ The word is "obtained" in my MS. copy but I think it must have been "maintained" originally.

elevations and depressions of land, which are known to have often occurred in every part of the world, are due to causes *still in action*.

165. I agree with Mr. Pengelly that the ground cannot have been *washed away* since Diodorus's time (much less can it have been washed away since 1086). He arrives at the conclusion that "twenty thousand years have barely sufficed to carry us back to the 'wood' era, on the hypothesis of washing away (M.S. p. 19).

The ancient block of tin which was dredged up about 1823, in Falmouth harbour,* if we suppose it to have dropped during its transit to the Isle of Ictis (and I know not what else can be inferred from finding it there) would seem to place Ictis opposite Falmouth harbour, and therefore twenty miles east of St. Michael's Mount. Sir Charles Lyell's views, in the new volume of his grand work, as to the identity of the Mount with Ictis, are similar to Mr. Pengelly's, whom he quotes.

166. I have before me *in extenso* Dr. Boase's paper (with section) on sandbanks on the N.W. shore of Mount's Bay,† called the Greens. He arrives at the conclusion that "it appears probable that at a remote period these banks filled the greater part, if not the whole of the Bay; and that they have been for ages past, as at the present day, gradually diminishing under the incessant attacks of the waves." He found under a bed of sand ten feet thick, and under a bed of pebbles about sixteen feet thick, on which the sand rested, masses having the appearance of decayed timbers of a ship, perforated by *Pholas Dactylus*. Large trunks and branches of trees were laid along in every direction, in a bed of very dark brown colour. Some portions of the branches were perfect, being covered all round with bark, in a state of great preservation; the trunks are never entire, being split longitudinally, as if they had been crushed. The trees were small, from six to nine inches, rarely a foot in diameter. One piece was fourteen feet long, but not an entire trunk. Far the greatest part of the wood is hazel, with pieces of alder, elm, and oak; these are interspersed with decayed plants and bark, leaves, and twigs of trees, sufficiently perfect to show that they were almost entirely hazel. Hazel nuts were very abundant, the shells in a good state of preservation, but the kernels have entirely disappeared. There were stems and seed vessels of grasses and fragments of insects,‡ particularly elytra and mandibles of the beetle tribe, still displaying the most beautiful shining colours. On exposure to the air these soon crumbled into dust. He remarked a fœtid odour resembling sulphuretted hydrogen gas. Similar terrestrial remains extended into the marsh beyond high-water mark, as in Guernsey.

The section shows the ligneous bed (not lignite), 3ft. thick and extending 240ft. northwards from high water into the marsh, and upwards of 100yds. southward to low water, where the top of it (covered with a little sand) forms the sea-bed, being continuous all under the beach and the Green, from the marsh to low water. Some parts, as we have seen, had the branches "perfect, covered all round with bark, and in a state of great preservation," plainly signifying that we are not *obliged* to go back to an earlier period than 1099 for their submergence. I think there can be no doubt that within the Christian period the trees must have been alive and flourishing. I can see no reason for attributing them to an earlier date, so far as regards the description and state of preservation of the wood, than similar deposits of about that date on the Norman and Breton coasts. They are only somewhat darker in colour than the submarine wood of the shores of Jersey, which is as recent as 1356, and from which I do not gather that they differ in other respects.

167. Sir Henry de la Beche,§ speaking of the whole English coast which lies west of the 3° of west longitude, says "submarine forests are so common that it is difficult not to find traces of them in the district at the mouths of all the numerous valleys which open upon the sea, and are in any manner silted up, so that we may consider they once formed creeks, or the bottoms of estuaries." Sir Henry then gives details as to various submarine forests on the south coasts of Devon and Cornwall, on the north-west coasts of Cornwall and Devon, and on the north coast of Somerset as far east as Bridgewater. In some of these pre-historic remains were found, which I attempted to show in the latter part of Art. 133, did not necessarily prove that the very latest sinkings there took place in pre-historic times. And of the others the terrestrial remains are of species still in existence near at hand. The elytra and maudibles of beetles are a parallel case to Ogée's fact of the year 709, "when a prodigious quantity of insects and plants of all species died and rotted in the marshes of Dol."|| And Mr. Herapath's remarks on the *still fœtid* state of the remains of the Genus Synapta, off Guernsey, perhaps also signify a date not earlier than 709.¶ If the Rev. W. Borlase (Art. 133), instead of using the round number 1000, had happened to say 1048, it would have fixed his subsidence in 709, which was the year of the great subsidence about Mont S. Michel and the neighbouring coasts of Normandy and Britanny.

We have still Vice-Admiral Thevenard's submersion "of the western extremity of England near the Scilly Isles at the commencement of the ninth century," to account for, see Art. 209. But I do not insist on this. He may have meant the eighth century, when the Rev. W. Borlases's and the great French submergence (709) took place.

168. At Mainporth, between Mawnan and Falmouth, the Rev. Canon Rogers noticed the submarine stump of an oak in the situation in which it grew, the roots, as usual, running amid peat, bearing evidence of having been formed in marshy ground, and containing, he thought, the leaves and roots of *Iris pseudacorus* (the common yellow flag), now growing in the adjoining marsh.* He also saw remains of a submarine forest with stumps of oaks and willows where they grew a little above low-water mark, at Porthleven, near Helston.†

"In the Hayle estuary we again have evidence of trees and vegetable accumulations beneath the present level of the sea, and under the Dunbar Sands; at the mouth of the Camel a similar bed has been seen. Traces of submarine forests occur also at Perron Porth, Lower St. Columb Porth, and Mawgan Porth, between these two localities. A similar vegetable bed is stated to be found beneath Braunton Burrows, at the embouchure of the Taw and Torridge, near Barnstaple and Bideford. At Porlock a small submarine forest is well exhibited at very low tides, the stumps of trees, which appear chiefly oaks, standing "in the positions in which they grew. The present action of the sea has bared these trees by removing the silt and sand which once covered them, as can be seen by the continuation of the same bed of vegetable matter inland, beneath sands and silt, behind the present shingle beach that merely reposes, as can easily be seen, upon the inclined plane of the submarine forest."‡ The description in the last sentence is exactly true of much of the north-west coast of Guernsey. Sir Charles Lyell says if we "turn to the Bristol Channel, we find that both on the north and south sides of it there are numerous remains of submerged forests; to one of these, at Porlock Bay, on the coast of Somersetshire, Mr. Godwin-Austen§ has lately called particular attention, and has shown that it extends far from the land." ("Principles of Geology," 1867, p. 545.) Sir Charles supposes that a woodland tract once extended all across the Bristol Channel from Somersetshire to Wales, through the middle of which the ancient Severn flowed. If such a tract of land once existed, he well observes, the caves and fissures in the precipitous cliffs on the south coast of Glamorganshire may have been frequented by various animals, all now extinct. In all this there is nothing to prove, that submergences of the forests referred to in this article, may not have taken place within the historical period.

169. Sir Henry proceeds to say, that "another smaller vegetable accumulation is found near Minehead; and among the compressed plants and trees the bones and horns of the red deer have been discovered, a species still wild in the adjoining district of Exmoor. Proceeding eastward along the southern shores of the Bristol Channel, a submarine forest occurs beneath a considerable portion of the Bridgewater levels, and which is well seen to pass beneath the present level of the sea towards Stert Flats. That portion which appears near Stolford has been described in detail by Mr. Leonard Horner,|| who notices *Zostera oceanica* among its peat. Professor Buckland and the Rev. W. D. Conybeare consider that the trees at Stolford afford very clear evidence of having grown on the spot where they are now seen, and they have further noticed that trees of large dimensions—fir, oak, and willow—are found in the marshes of the levels at the depth of of 15 or 20ft. from the surface; trunks lying prostrate, and stumps with their roots, in the upright position in which they grew. Intermingled with them are furze-bushes and hazel-trees with their nuts; the whole being, as it were, bound together by a bed of reeds and other palustrine plants.¶

"Part of this vegetable accumulation may be comparatively modern."

170. All the terrestrial relics, now submarine, bear so close a resemblance in their character to the submarine relics on the French coasts, which we *know* have been submerged for the most part within the last dozen centuries,—that, as I believe, we can scarcely avoid coming to the conclusion that the submarine trees and terrestrial vegetation, now below the sea on the English coasts, must be equally modern. On the occasion of my reading a paper on this subject to the Geological Section, at Birmingham, I exhibited part of a submarine tree taken from the sea-bed near St. Helier, where it must have been covered at high tides with from 15 to 20ft. of water. This specimen which I had previously caused to be split along its centre, one of the committee said he thought was "modern," and no one dissented.

171. "It is certain," says Abbé Manet, p. 33, "that the famous Bernard

* "Lyell's Principles of Geology," 1867, p. 451.
† "On the Sand Banks of the N. Shores of Mount's Bay," by H. S. Boase, M.D., vol. ii., p. 136, &c., of "Trans. Roy. Geo. Soc. of Cornwall," read Oct., 1826.
‡ Ogée mentions the prodigious quantity of insects and plants found in Britanny under like circumstances.
§ "Report on Cornwall," &c., p. 417, &c.
|| See last part of second paragraph of Art. 76.
¶ See third paragraph, Art. 121.

* "Trans. Geol. Soc. of Cornwall," vol. iv., p. 431.
† Ibid, vol. i., p. 236, and vol. iv., p. 482.
‡ Sir H. de la Beche's "Cornwall," &c., p. 118.
§ Memoir rean Nov., 1865. Geol. Proc.
|| "Geol. Trans." vol. III., p. 380. ¶ *Ibid.* second series, vol. I., p. 310.

d'Abbeville who went to live there in the year 1089,"—that is to say, in the then *peninsula* of Chausey, see Art. 58 (second paragraph) "left it about the year 1105." It is *possible* that Chausey may have become what it is now, namely, a large group of rocks six miles distant from the coast, and all bare, except the chief one which is about a thousand paces long, and covered with a sandy soil, in the year 1099. When we consider the great distance towards Cornwall which the neutral district of the Channel Islands seas extends, it is at least *possible*, as I have said, that the sinking may have extended all across the English Channel to Western Normandy. In the same way the Rev. W. Borlase's date of *about* 757 for the submersion near St. Michael's Mount, may have been at the identical date of the great French submergence in 709. Therefore the sinkings then may also have extended also, across the English Channel.

Summary as to the ancient South-west Coast of Britain.

172. The Rev. W. Borlase has established a sinking of at least 16ft. (perhaps much more) at the Scilly Isles since the time of the Romans,* which accounts for the loss of the ancient tin mines, and Ptolemy has correctly laid down the latitudes and longitudes of places on the north coast of Britanny, with reference to the Isle of Wight and Lizard Point, although the English Channel, a hundred miles wide, intervened. And though some of his figures are either corrupt, or he must have made mistakes in the interior of France, there appears to be no reason for disbelieving his position of the Antœuestæum promontory, though it falls far out in the Bristol Channel; because he could do correct work, and there are the Lionesse tradition and the "inundations" of the 8th century, 1014, and 1099, to support that position. Moreover we have seen in Art. 48, the truth of the tradition that Mont S. Michel was once ten leagues from the sea, actually established by his position of the mouth of his river Argenis.† All this lends a certain degree of countenance to the corroborative traditions as to supposed lost land at Seven Stones.‡ And this again is supported by Florence, of Worcester's, statement that St. Michael's Mount was formerly five or six miles from the sea; and again by Ptolemy's position of the Lizard at seven miles seaward of its present place, and as a coping-stone or climax to the whole, we have the actual existence of abundance of submarine forests on the south-west coasts of England. And no violence would be done to probability, if, by reason of the freshness of some of the trees, &c., and their general resemblance to other submarine forests on the French coasts, submerged in 709 and since,—we were also to lay it down as a fact, that very extensive submeagenee of land on the south-west coasts of England, must have taken place since Ptolemy's time, and the supposed approximate coast-line then, is shown on the map in accordance with these reasonings, for they all point to one and the same conclusion.

172a. Notwithstanding all the proofs and probabilities in opposition to the theory that the mount is Ictis, which are accumulated in this chapter. My friend, Mr. Pengelly, in answer to my suggestion that his paper had better be written without insisting on the identity of Ictis with the Mount, declares that he is afraid he is so "obtuse" (the word is his own) "as to be utterly unable to see that the statement in Domesday Book has the remotest bearing on the question." "In fact," he says, though he has read all he can find on the topic, he has "not found even the ghost of an argument against the claim of the Mount to be considered the Ictis." I believe my readers will entertain a very different opinion, and think it by no means improbable that my friend himself may before long, wish he had adopted the suggestion. He is sorry to find that though in his "Submerged Forests," he correctly quoted Dr. Boase, the doctor himself is in error. "It was not Florence, but William of Worcester (about 1478) who states that the mount was 'formerly five or six miles from the sea, and enclosed with a very thick wood.' He does add that it was formerly called 'Le Hore rock in the Wodd,' but he does not mention its name in the British language. I (Mr. Pengelly) have lately had an opportunity of perusing his Itinerary,—written in Latin." Mr. Pengelly has "also perused Florence of Worcester, who does not, in any way, allude to the Mount," meaning, I suppose, that as the Mount is not mentioned by name, the catastrophe of 1099 cannot refer to it. To be consistent, my friend ought to go further and argue that because no locality whatever is mentioned for the destructive event of 1099, that therefore that event, though stated by Florence and corroborated by the Saxon Chronicle, occurred nowhere, but is a myth; which would be absurd. I submit, on the other hand, that those who search for scientific truth, and like myself care for nothing else in this matter, will be glad of the elucidation afforded by the event of 1099, because it explains the loss of the 200 acres, which would otherwise be unexplainable. I have argued this question at much greater length than I otherwise should, out of deference to my friend; for, as I think, most of my readers will before now have arrived at the conclusion that the identification of the Mount with Ictis is an untenable position. I have no book of reference here except "Watts's Bibliographical Dictionary," which makes no mention of William of Worcester, but gives "William of Newborough. Historia, sive Chronica Rerum Anglicarum, ed à Tho. Harenc, Oxon. 1719, 8vo." But he (Watts) does not give the date of the history, I however, accept the date 1478, on my friend's authority, and presume he means to contend that since the record as to the former distance of "five or six miles from the sea," is of such a comparatively modern date, that therefore it is not to be believed in; if so, that is an opinion from which I entirely dissent. I think we ought to follow the usual rule, and believe ancient records which contain statements neither impossible or improbable, especially if the author's veracity (as in this case) has never been called in question. If William of Worcester only recorded this important fact in 1478, he doubtless had authority, and did not forge it.

172b. I think my friend's is another case, in addition to several which have been noticed in previous chapters, where distinguished men of science occasionally cannot see and do not believe facts opposed to their own preconceived ideas. Though the high and unimpeachable authority of "Domesday Book" establishes fully that the Mount was at least eight times as extensive in 1086 as at present, and though he himself fully establishes the fact that the "washing away" can only have been of trifling amount in the last 2,000 years,* and though "Domesday Book" gives us not the least ground for believing that the Mount had become an island, even at the end of 1,100 years after Diodorus, yet my friend is utterly unable to see the fact that the Mount could not have been then, and consequently is not now, the ancient Isle of Ictis. More especially so because though "Domesday Book" carefully explains when estates are situated in islands, as in the cases of Portland and Wight, and though it never mentions that the Mount was then an island any more than that Tavistock or any other properties at miles distance from the sea were islands; yet my friend declares that he has "not found even the ghost of an argument against the claims of the Mount to be considered the Ictis." Again, though it is found that Florence of Worcester and the Saxon Chronicle both agree in stating to the effect, that on the 11th November, 1099 (though it could neither have been an equinoctial nor even a spring tide and consequently must have been a sinking of land) the sea "came out upon the shore, and buried towns and men very many, and oxen and sheep innumerable," and though more than 200 acres of the Mount are missing, my friend will not accept this, the *only way* of accounting for the loss, simply because neither Cornwall, nor any other county is mentioned by name. Neither does he make any attempt to account for the loss himself. Again, when we find an ancient chronicler declaring positively that the Mount "was formerly five or six miles from the sea," my friend will not believe this, though it is corroborated by Ptolemy's position of the Ocrinum promontory, because it was William (not Florence) of Worcester who stated so about 1478. Very well, there is nothing incredible in William's statement, and we may not disbelieve and entirely reject the ancient chroniclers, *merely to suit a modern theory*. Another highly distinguished man of science ridicules the idea of the former existence of the Lionesse country, by calling it a "romantic tale." He says, "Although there is no authentic evidence for this romantic tale, it probably originated in some former inroads of the Atlantic, accompanying, perhaps, a subsidence of land on this coast." As this eminent gentleman admits that there may have been a subsidence of land and an inroad of the sea on this coast, how can he arbitrarily limit either its length, breadth, or depth; as if he meant to say, "I won't believe in it if you allege that it exceeded (a certain mental number of) acres." Yet the gentleman might have remembered a case, with which he is well acquainted, where a greater tract of land than I contend has sunk on the Cornish coast, namely, 2,000 square miles, were in a few hours converted into an inland sea or lagoon. I refer to the sinking of the Runn of Cutch, so lately as in June, 1819.† To come nearer home. At p. 549 in the 1867 edition of "Principles of Geology," is a map showing the "Line of Coast from Nieuport to the mouth of the Elbe, in which changes have been observed since the historical period." The same map says "The dark tint between Antwerp and Nieuport (about 2,000 square miles in area), represents part of the Netherlands which was land in the time of the Romans, then overflowed by the sea before and during the fifth century, and afterwards reconverted into land." The distance along the coast from the mouth of the Elbe to Nieuport is 350 miles. I ask why anyone doubts that extensive tracts of land have often risen and sunk during the historical period? If these gentlemen will examine Sir Charles Lyell's "Principles of Geology," and Mr. Charles Darwin's "Voyages of the Adventure and the Beagle," with both of which works they are well acquainted, they will find plenty of other proofs both of risings and sinkings of land within the historical period. Moreover, we have the Rev. W. Borlase's distinct testimony (Art. 150), establishing a sinking of at least sixteen feet at the Scilly Islas since the

* Art. 150.
† If the Lionesse country really existed it was probably submerged in the 8th century or 1014, for no such name occurs in Domesday Book.
‡ See commencement of Art. 114.

* See his MS. on "The Insulation on St. Michael's Mount,', pp. 19, 20, 24, 25.
† See Lyell's "Principles of Geology," 1853, p. 461.

Roman invasion of Britain. And the losses of land caused by the catastrophes in the eighth century, in 1014, and in 1099, have also to be taken into consideration. My friend's argument has dwindled now only to this (for I think everything else which he relied upon has been upset), and it starts with begging the very question which is, in reality, the main point in debate: —"*If there have been no geographical changes on the coasts of Cornwall since Diodorus's time*, then Mount St. Michael must be Diodorus's Isle of Ictis, because there is not now, and (begging the words in italics) there cannot have been then, any other island on the Cornish coasts large enough to be worth mentioning"

Volume II, which will be published when one hundred subscribers at 5s. each are obtained, will contain:—

Farther accounts of submergences, chiefly about Sercq.

What can be gathered from the ancient writers, Nennius and Gildas. on the unique privilege of neutrality of the Channel Islands' seas in all wars which formerly existed; and its probable origin in sinkings of land.

Two chapters on losses of land on the French coast of the Bay of Biscay. It is not a little remarkable that Pomponius Mela (A.D. 35) says: —"from the mouth of the Garumna (Giroude) that side of the land (of Gaul) runs into the sea, and is opposite the Cantabrian shores." Now, Cantabria means Biscay, which *is not* opposite the mouth of the Gironde, but Ptolemy's ancient mouth of the Garumna *is* opposite to Cantabria or Biscay; and the Isle of Antros may not have been Cordouan, as commonly supposed, but Antros may have been situated as shown by the + on Map 2.

A forged chart. Probable sinkings of land at the mouth of the Somme within the historical period; and on the coast of Belgium, Holland, and Schleswig.

General remarks on sinkings of land in various parts of the world, during the post-tertiary period and down to the present time, with a view of showing that risings and sinkings of land have continued to occur throughout all geological time. Thus an attempt is being made to trace a small part the operations of the over-ruling and omnipotent Creator.

AN UNFORTUNATE STEAM NAVIGATION COMPANY.

The Bahia Steam Navigation Company recently purchased the Clyde-built river steamers *Vesper*, *Lennox*, *and Leven*, for the South American River Wade; the first of these vessels was built last year by Messrs. Barclay, Curle, and Co., for Capt. Campbell, and was engaged plying on the Glasgow and Kilmun line up to the time of her purchase by the Bahia Company, when, having been re-named the *Leitao Currha*, she sailed from the Clyde on the 3rd January last, and foundered on the 19th of the same month, about forty-five miles north-west of St. Ives. Shortly after mid-day on the 19th January, her iron plates on both sides began to break and part asunder, and about 3 p.m. she broke into, and before all the people could be removed from the ship to the steamer *Vigilant*, which providentially hove in sight, three men went down with her and perished. The crew which joined the *Vesper* when she put into Holyhead, were dissatisfied with the condition of the ship, which they considered was not sea-worthy, and only on compulsion were they induced to fulfil their engagement. The *Vesper* was 170ft. long, by 18ft. beam. The other two vessels, the *Lennox* and the *Leven*, were each 140ft. long, by 14ft. beam, and 55 tons register, and were built in 1864 by the Clyde Shipbuilding Company, near Port-Glasgow, and engined by Messrs. Rankin and Blackmore, Eagle Foundry, Greenock, for the Dumbarton Steam Packet Company, both steamers being until recently engaged, carrying goods and passengers betwixt Glasgow, Dumbarton, and Greenock. Having been purchased from their owners by the Bahia Steam Navigation Company for the South American river trade, and re-named respectively the *Tavarnes Baston* and the *Sevarres*, the tiny craft had their paddle-wheels unshipped, and having been rigged as schooners, were towed down Channel. The *Tavarnes Baston* (late *Lennox*) had only been left a few hours by the tug-steamer, when she drove ashore under Salthill Station, near Kingston, and became a total wreck on the 17th March.

The *Sevarres* (late *Leven*) left the river on the 2nd March, and was left by the tug below Ailsa Craig. Having been subsequently forced to seek shelter in Lockryan, she again started on the 7th March, and was left by the tug far down the channel, and was abandoned in a sinking state off the coast of Ireland on the 20th March, thus making the third steamer belonging to the Clyde, purchased by the Bahia Company, which has been lost in the Channel within the past few weeks. The value of the three vessels is estimated at from £8,000 to £10,000. The propriety of sending such a class of vessels to sea, especially at the season of the year when they left the Clyde, is very questionable even in a commercial point of view, apart altogether from the risk of human life which attended such venture.

THE AMERICAN CHINA MAIL.

This line, inaugurated at the commencement of the present year by the sailing of the *Colorado* from San Francisco *viâ* Honolulu and Kanagawa to Hong Kong, is considered a permanent success. Two additional steamers of the Pacific Mail Steam Ship Company, the *Great Republic* and the *Celestial Empire*, are to leave New York on May 1 and June 1, respectively, to take their places in the China line. The first of these vessels was built in the shipyard of Henry Steers, at Greenpoint, N.Y.; the second, being the exact counterpart of the *Great Republic*, was built by Mr. W. H. Webb, N.Y. The sister ships are the largest wooden merchant steamers ever built in the United States. Their dimensions are as follows:—Length between perpendiculars at load line, 360ft.; breadth, extreme, including outer planking, 50ft.; depth of hold to top of spar-deck beams, amidships, 31ft. 6ins. Each vessel has three full decks, an orlop-deck at each end, extending to boiler and engine bulkheads, also a platform in lower hold to receive cargo and coal. The floors are entirely of white oak, and the sides of pitch pine.

The following are the particulars of the engines, built at the Novelty Iron Works, New York:—Each vessel has a beam engine of 105ins. diameter of cylinder, and 12ft. stroke of piston, fitted with balanced poppet valves and Allan's adjustable cut-off; a surface condenser with compressed wood packings for the tube joints, and supplied with condensing water by an independent rotary pump, driven by a pair of direct-acting engines placed between air pumps and cranks; the feed pumps having each its own suction pipe from tank, and discharge pipe to boilers; the horizontal tabular boilers placed forward of the engine, fore and aft the ship, and uptakes connecting into one funnel.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

FLOATING STEAM FIRE-ENGINES FOR CALCUTTA.

To the Editor of The Artizan.

Dear Sir.—We notice in your last number that you state the hull for the "Floating fire-engine for Calcutta" was built by Messrs. Richardson, Duck, and Co., on the Tyne. Will you please insert in your next, that the hull was designed and built by Messrs. Richardson, Duck, and Co., of Stockton-on-Tees, and oblige, Yours truly,

Richardson, Duck, and Co.

South Stockton Iron Shipyard, Stockton-on-Tees,
April 25th, 1867.

REVIEWS AND NOTICES OF NEW BOOKS.

The Channel Railways connecting England and France. Illustrated by Chart of Soundings, and lithographed plans. By James Chalmers, Inventor of the Chalmers' Target. Second edition. London: E. and F. N. Spon. 1867.

The character of this project was briefly explained in our review of the first edition of the work, in The Artizan for November, 1861, page 260. It is originally to connect England and France by a strong iron tube, imbedded at the bottom of the sea, and capable of containing two lines of rail. The author now proposes to use two tubes, cased with timber, and lined with brick, each containing a single line, and reaching from shore to shore on the bottom of the channel, the main portion of the work, from embankment to embankment, being eighteen miles in length; three ventilators, one in mid-channel, and one about a mile from either shore, to supply the requisite quantity of air. We need not go any deeper into the merits of the project, as we have had no occasion to change our opinion expressed in the previous notice. We may add, however, that the fact of the project not having met with greater success hitherto, is due chiefly to the aversion of the monied classes to contributing to the furtherance of a project open to so much controversy. At this moment the Wapping Thames Tunnel is still the longest artificial subaqueous passage in the world; some similar tunnels proposed of late years, such as the Mersey Tunnel between Liverpool and Birkenhead, or the East River Tunnel, between New York and Brooklyn, do not seem to find much favour with capitalists and the public at large, and yet neither of these projects contemplate passages under sea of more than one-tenth the length of the proposed channel tubes. We think, therefore, that an application of Mr. Chalmers's principle in the Mersey, the East River Sound, or between the Scylla and Charybdis should precede, instead of following the realisation of his channel railway, which will hardly meet with the favour of the public, so long as it has not a sound footing in a substantial precedent.

The Technologist. A Record of Science, its Progross, Literature, and Practical Appliancos. Edited by Eldridge Spratt, Esq. New series. London: Kent and Co. 1867.

"Popular Science" has got somewhat into disrepute since penny papors commenced making stop-gaps of stray bits and morsels of that commodity, which thoy served to their readers as souud nutrimeut, which sooner or later proved altogether indigestible of late years only somo writors of merit have taken to couching their works in language doubtless not intended for tho humblest intellects, yet sufficiently divested of special technical terms as to bring them withiu the reach of intelligent outsiders. This tendency we cannot but fully approve of, howsoever we may object to the manufacture of articlos of scientific literature for consumption "by the million," or "*à la portée des gens du monde*," as the French term is. The "Popular Science Review" has done much to counteract the injurious influence of "scientific" penny literatnre, and if it has not entirely put down the interlopers this is due chiefly to its appearing only at longer intervals. Tho periodical under notice being published in monthly shilling parts, is likely to secure popularity at least amongst the owners of shorter purses who are yet desirous of intellectual improvement in the various branches of science. A statement of the contents of the last number which we have beforo us will give a fair idoa of the character of the "Technologist." We find in the April number articles on:—

- The Samaritans and the Samaritan Pentatench.
- The Commerce of Mexico.
- Vegetable Fibres available for Textile Fabrics.
- The Royal Society Soirée.
- Is Medicine a Science?
- On the Mechanical Process of Engraving.
- Capt. Majendie on Small-arms.
- Reviews, &c.

This bill of fare contains several very substantial dishes, and much praise is due to the caterer, Mr. Spratt, for the appropriate selection and the seasoning by which they are rendered more palatable. We approve the plan on which this publication is worked, and hope it will more and more succeed in the object it is aiming at, which is, tho spread of scientific knowledge in all its branches among the educated but non-professional classes.

The Doctrine of the Correlation of Forces. By the Rev. J. Cranbrook. Edinburgh: Edmonston and Douglas.

In this pamphlet the autbor professes to give a review of the evidence which has given rise to the gradual growth and development of the tbeory of continuity, so prominently brought before the public by Mr. Grove in his late address to the British Association, and endeavours to establish its claim to our acceptance by the force of the evidence adduced.

Into the nature of that evidence it is necessary that we should inquire, in order to test tbe value of tbe general conclusion drawn from it.

Mr. Cranbrook starts by laying down the principle, tbat tbe two fundamental axioms which have been amply verified in the world of matters, viz.:—*ex nihilo nihil fit* and *nil fit ad nihilum*, apply not alone to matter, but also to tbe various forces by which matter is governed; tbat is to say, just as there is no adding to, nor taking from, the bulk of the material world, so also can there be no creation nor annibilation of force in nature; and he justifies tbis assertion, in so far as it applies to the pbysical forces, first by reminding tbe reader of the great analogy, and the mutual dependence upon one another, which exist between light and heat, hetween beat and chemical force or affinity, hetween cbemical force and electricity, between electricity and magnetism; and then from tbe well-known fact that heat and mechanical work are mutually convertible and indestructible, be draws the conclusion previously stated.

We sball here observe, that up to this point we agree with our autbor in that we feel sure that scientific observation will ultimately be able to establish beyond a doubt that all the forces named are mutually convertible; but confining our remarks to our own world we do not see how he can reconcile the assumption of tbe non-creation of new force with the fact of the continuous emission of heat from the sun, when himself admits that such beat is tbe primary source of all force or power; for to all intents and purposes, the conversion of any fresh quantities of heat received by this world into any kind of force, is equivalent to the creation of new force upon this globe, in what manner soever the heat of the sun may be generated, or whatever be its cause.

Mr. Cranhrook afterwards passes on to the consideration of wbat he terms the vital forces, namely, those forces by the agency of which vegetable and animal life are called into existence, and from no other evidence but the analogy or similarity of nervous with electric force, he draws the conclusion that those *supposed* forces are similar in every respect with the physical forces enumerated, and like them are mutually convertihle, qualifying, however, his assertion hy the following statement, which unquestionahly figures in his essay as a postulate upon wbich the whole theory of the continuity or correlation of species rests:

"Thero are four planes of existonco which may be regarded as beiug raised ono above the other. Tho first is, the plano of elementary existonce; tho socond, the plano of chemical compounds or of tho minoral kingdom; tho third is the plano of vegetable existence; and the fourth the plane of auimal existence. It is apparently impossible for any known force in naturo to raise mattor through all these planes at once; *on the contrary, there is a special force adapted for the elevation of matter from each plane to the plane above.* It is the special function of chemical affinity to raise mattor from plane No. 1 to plane No. 2; it is the special prerogativo of the force of vegetation to lift matter from plane No. 2 to plane No. 3; and, finally, the force of animal life alone enjoys the privilego of lifting matter still higher into the plaue of animal existence."

The genoral conclusion which he draws from this assumption, supported by the well-established principles of thermo-dynamics, is as follows:—

"With regard to *matter*, all that exists has been formed out of the *débris* of what existod in the past, and so with regard to *force*; creation simply means the induction of a special mode of motion (or force) out of a provious and different one; expeudituro means nothing more than the passing of an existent mode of motion (or force) into another."

Now, the object of tho theory which the essay under consideration detends, is avowedly to overthrow the received method of accounting for the phenomena of diversity and mutability in nature by a number of separate and miraculous creations; and, in order to accomplish this, it has been uocessary to assumo in the postulate above quoted that "there is a special force adapted for tho elevation of matter from cach plane of existence to the plane above," or, iu other words, that there are threo special forces continuously at work to bring about the various changes which are continuously going on in the material universe, and those phenomena of diversity which constitute the charm of life, and which had herotofore been held to be the direct and proximate result of the creative power of God. This theory, therefore, only dethrones God, or the Creator, or Providence, in order to replace Him by throe special forces which, though they are said not to create, are yet supposed to cause changes or mutations which, in so far as they affect the mind, and to all practical intents and purposes, are really new creations.

The wholo of the argumentation, thereforo, and the assumptious upon which this thoory rests, appoar to amount to nothing but a quibble of words, of which not the loast romarkable feature is the substitution of the Trinity as comprehonded in One God by three independont special forces; and, at any rate, it is an open question whether such a chango in our creed will tend to elevato the human mind, or tend to increase the sum of human happiness. For ourselves wo do not hesitate to answer that quostion in the negative; and we shall conclude this review by giving expression to our unqualified surprise, that any person should be found willing to waste so much time and ingenuity in the pursuit of an object, which uot only must be unproductive of practical results for good, but wbich may be doubly mischievous; first, by upsetting the doctrine of responsibility to a higher Being; and, secondly, by laying tbe seeds for tbat belief in fatalism wbich has been the barrier to every kind of progress among all Asiatic nations.

On the Velocity of Steam and other Gases, and the true Principles of the Discharge of Fluids. By R. D. Napier. London: E. and F. N. Spon. December, 1866.

This pamphlet is divided into two parts, viz.:—Article 1, On the Flow of Gases; aud Article 2, On tbe General Tbeory. In tbe first part the autbor endeavours to prove "tbat the greatest rate at wbich steam will flow from a boiler through an orifice into a vacuum is only balf, or ratber less than half, of that given in all publisbed tables on tbe subject." In the tecond be seeks to show "that the main cause of the contracted vein has been overlooked," and to explain "all the difficulties whicb, so far as the writer is aware, exist in tbe subject." The pamphlet is not written in very lucid language, aud we should not like to pass judgment on its merits, but would only draw our readers' attention to it, as a further contribution to this class of literature.

System der technish malerischen Perspective. Für technische Lehranstalton, Kunstakademien und zum Selbstunterrichte. A System of Perspective for engineers, painters, &c., by Franz Tilscher, Professor of Descriptive Geometry at the Polytechnic Institution, Prague. With an Atlas of 16 plain and 2 chromo-lithograpbic sheets of engravings. Prague: Friedrich Tempsky, 1867.

Tbe object of this work is to give tbe student a complete instruction in the laws of optics upon which perspective rests, and render this instruction unfailing hy introducing the requisite mathematical elements of that science. The author keeps the *constructive* and *optical* principles of perspective entirely distinct from each other, and thus summarises the system he endeavours to introduce:—

If we consider that the principles of construction for perspective projections are comprised in the general principles of construction for central (plain) projections, and cannot be understood without the latter; that the process of vision from which the laws of optics are derived, is in itself a special application of central projection, we arrive at the conclusion that, in drawing up a system of perspective the laws of central projection

should, above all, be developed more generally, and without any regard to their application to the construction of perspective images; that the essential modifications of the general method of construction should then be introduced. Only when this is done, may we proceed to derive the laws of optics from the process of vision, and lay down those conditions that must be complied with to transform a central (plain) into a perspective image. Only when the intimate relations between both sets of principles have been fully understood, the latter may be applied to the projecting and perfecting of perspective images.

This method, or at least the manner in which the author elucidates it, may be seem somewhat involved, yet if divested of unnecessary deductions, it seems plausible enough. It amounts to this, that in teaching mechanical, industrial, or artistic drawing, descriptive geometry, the laws of optics, and the application of the latter to perspective, should be proceeded with severally and gradually. This is done by the author himself in some 300 octavo pages, accompanied by an atlas of 18 folio plates. It admits of little doubt that the empirical method of teaching perspective mostly in use at the present day, is open to grave objections, and the introduction of a method based upon the principles of natural philosophy combined with analytic formulæ, has become a desideratum. It seems to us, however, that Herr Tilscher has gone somewhat too far; we do not think his system, being rather circuitous and intricate, will tend to render the subject as attractive to the student as might be wished.

The whole work is divided into three parts, viz.:—

1st. General principles of construction of central images of objects, based upon the "method of projective distances as a method of central projection."

2nd. Special modifications of the method of projective distances, as applied to the construction of central images, and

3rd. Principles and methods of application of the central projection to the construction of perspective images.

To those who make a special study of the science of perspective, Herr Tilscher's work will be invaluable; but for tutorial purposes or for self-instruction, where the student has little spare time on hand, it will be impossible to make use of it, at least in this country. As a monography of the subject, it is very well got up and highly creditable, both to the author and publisher.

Die Operationen der œsterreichischen Marine während des Kriegs 1866. (The operations of the Austrian navy during the war of 1866. The Episode on the Lake of Garda, the Italian Attack of the Island of Lissa and the Battle of Lissa. By S. ZIEGLER, Vienna: Carl Gerold and Sohn, 1867.

From 1827, when the united navies of Great Britain, France and Russia, under Codrington's command, annihilated the Turkish fleet, at Navarino, till last year, Europe did not witness any sea fight on a larger scale. No doubt, several minor collisions took place in the meantime; yet, by the side of Navarino, the battle of Sinope, in 1853, when the Russian fleet did great injury to the Turkish squadron, does not appear as anything but a minor combat; during the Russian war of 1854-56, the Russian Baltic fleet remained safely hidden in Kronstadt, and their Black Sea fleet was sunk in the harbour of Sebastopol without having struck a blow. Lastly, the encounter of a few Austrian and Prussian vessels with the Danish squadron, at Heligoland in 1864, was hardly more than a sham fight. On the other hand, the action of Lissa, being a regular naval battle, with the aggregate naval power of two nations ranged against each other, enlists our interest not merely on this account, but more especially as the first combat the results of which tend to show the comparative value and merits of ironclads and wooden-built vessels.

Ever since the affair of Hampton Roads in 1862, it has been universally accepted as a dogma that wooden ships, if opposed to ironsides, would fare no better than a clay pipkin fighting against an iron pot. The day of Lissa, however, has proved that this view, though it be well founded and plausible in substance, can stand its ground only, if in *all* other respects the two parties in the combat are equal to each other. It has shown that if material superiority be nearly all gathered on one side, moral superiority all on the other, the latter will yet hold its own and may even conquer, notwithstanding the most overwhelming disadvantages.

The accounts of the time, corroborated by the irrefutable evidence lately brought forward at the trial of Admiral Persano, leave no doubt that in point of *matériel* the Italian navy was as favourably situated as could possibly be wished for.

The Italian Government, in combining the original Piedmontese with the former Sicilian fleet, and keeping the whole up to the mark by adopting all the more recent improvements, had, in point of number and material strength, raised the navy to the third rank in Europe.

Twelve French, American, and British-built iron-clads, armed with an aggregate of 248 Armstrong, Cavalli and French rifled guns, formed its backbone, and altogether the fleet was well armoured and well armed. It consisted, besides the iron-clads, of eight wooden vessels with 360 guns, four gun-boats with 16, and ten paddle-wheel steamers, with thirty-two guns; total, thirty-four vessels, with 656 guns, 14,760 horse-power, and 10,706 men.

The Austrian navy was, both numerically and physically, greatly inferior to its antagonist. Very little had been done to bring it up to the mark, and all that had been done, bore upon it the stamp of palliative and make-shift. "For several years past," to us the author's own words,

"The Austrian navy had been labouring under the burden of the peculiar position of the country, financial difficulties and the painful consciousness of the total indifference the population of the interior had at all times evinced for maritime affairs. Even in the Reichsrath our endeavours, although they were favoured with patronising smiles, were resisted; the iron necessity of economy was ever opposed to the most weighty arguments brought forward in our support. It is true that in those days it was not yet possible to uphold the main argument in favour of the increase of the fleet, viz., the intention, manifestly evinced by Italy in last year's war, to conquer Dalmatia and Istria. All grants for the navy, though its *raison d'être* was complacently admitted, were reduced or even rejected, and all that was done under such circumstances could be realised only by the most strenuous and trying exertions and the most prudent economy. The supplies, scantily granted, were allotted to the various branches with hair-splitting (*fingerzæhlend*) accuracy."

In spite of, and partly perhaps owing to these drawbacks, the Austrian admiralty endeavoured to gain in moral efficiency what the fleet lacked in material strength. To the twelve Italian iron-clads, it could not oppose more than seven, some of inferior build, armed with 173 guns; and on the whole it laboured under great disadvantages numerically, as shown by the following figures:—

Aggregate number of	Italian Navy	Austrian Navy.
Ships	34	27
Guns	656	526
Horse-power	14,760	10,100
Men	10,706	7,492

The results of the action showed that the superior training, discipline, and efficiency of the men more than counterbalanced the material inferiotity. Of the whole of the operations of both navies previous to and during the battle the author gives a most lucid and exhaustive account, which, though forming obviously an *ex parte* version, deals very fairly with the unsuccessful adversary. The language of Herr Ziegler's narrative is generally forcible and to the point. There are but few passages in which he deviates from this rule, as, for instance, when describing the approach of the Austrian fleet:—

"*Ecco i pescatori*," exclaimed Admiral Persano, with sovereign contempt, on beholding the Austrian fleet coming up. But as Themistocles showed, in the waters of Salamis, what a small number of well-led ships could do against the unshapely, though greatly superior naval power of the Persians, thus Tegethoff defeated Persano's fleet at Lissa."

Such bits of buncombe may be very pardonable in newspaper accounts, but are out of place in works professing higher aims.

The narrative of the contest near Lissa is preceded by an account of the doings of half-a-dozen Austrian gun-sloops on the Lake of Garda, which are, of course, altogether insignificant by the side of the operations of the Adriatic squadron.

The small work under notice is illustrated by various diagrams, showing the order of battle of both fleets, the Italians being ranged with their iron-clads in one straight line, and their other vessels forming a shapeless gathering; while the Austrians advanced in a wedge-shaped (*staffelförmig*) array, by which they succeeded in breaking the Italian line. Another diagram shows to what extent the *Erzherzog Ferdinand Max* entered the sides of the *Rè d'Italia* on ramming the latter vessel. On the whole, Herr Ziegler's little work will be very interesting and useful to all those connected with nautical affairs, and naval warfare in particular.

BOOKS RECEIVED.

"A Treatise on the Screw propeller, screw vessels and screw engines, as adapted for purposes of peace and war." By JOHN BOURNE, C.E. London: Longmans and Co.

Parts XVII., XVIII., and XIX., containing:

Chapter III. Scientific Principles concerned in the operation of screw vessels, concluded.

Chapter IV. Comparative efficiency of screw and paddle.

Chapter V. Comparative merits of screws of different kinds.

Plate engravings: Machinery of H.M.S. *Waterwitch*; H.M. steam yacht *Fairy*; French mail steam packet *Paon*; screw steam yacht *Fire Queen*; French auxiliary screw dispatch steamers *Biche* and *Sentinelle*; H.M. screw steamer *Rattler*; screw steamers *Great Britain*, *European* and *Frankfort* American turret vessels *Chickshaw* and *Nanset*; and screw steamer for navigation of canals.

"Design for an exhibition building, with suggestion for method of classifying the proposed exhibition of 1862." By G. Maw and E. J. Payne. (London, Cox and Wyman, 1865).

"The French universal exhibition of 1867," by the same.

"Exposition universelle française de 1867," by the same. (London, Cox and Wyman 1867).

"Prize Essay upon the Encroachment of the sea between the River Mersey and Bristol Channel. By John E. Thomas. Read at the National Eisteddfod, 1866. London, E. and F. N. Spon, 1867.

"First annual report of the Aeronautical Society of Great Britain, 1867." London, Cassell, Petter and Galpin, 1867.

PRICES CURRENT OF THE LONDON METAL MARKET.

	March 2.			April 6.			April 13.			April 20.		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, selected, per ton	82	0	0	82	0	0	82	0	0	82	0	0
Tough cake, do.	81	0	0	80	0	0	80	0	0	80	0	0
Copper wire, per lb.	0	1	0½	0	1	0½	0	1	0½	0	1	0½
„ tubes, do.	0	1	0	0	1	0	0	1	0	0	1	0
Sheathing, per ton	84	0	0	84	0	0	84	0	0	84	0	0
Bottoms, do.	90	0	0	90	0	0	88	0	0	90	0	0
IRON.												
Bars, Welsh, in London, per ton	6	10	0	6	10	0	6	10	0	6	10	0
Nail rods, do.	7	0	0	7	0	0	7	0	0	7	0	0
„ Stafford in London, do.	7	10	0	7	10	0	7	10	0	7	15	0
Bars, do.	7	10	0	7	10	0	7	10	0	7	15	0
Hoops, do.	8	12	6	8	12	6	8	12	6	8	15	0
Sheets, single, do.	9	10	0	9	10	0	9	10	0	9	10	0
Pig, No. 1, in Wales, do.	4	5	0	4	5	0	4	5	0	4	5	0
„ in Clyde, do.	2	14	0	2	14	0	2	14	0	2	14	0
LEAD.												
English pig, ord. soft, per ton	20	0	0	20	0	0	20	0	0	20	0	0
„ sheet, do.	20	5	0	20	5	0	20	0	0	20	5	0
„ red lead, do.	21	15	0	20	15	0	20	15	0	21	5	0
„ white, do.	27	0	0	27	0	0	27	0	0	27	0	0
Spanish, do.	19	0	0	19	2	6	19	2	6	19	0	0
BRASS.												
Sheets, per lb.	0	0	10	0	0	10	0	0	10	0	0	10
Wire, do.	0	0	8½	0	0	8½	0	0	8½	0	0	8½
Tubes, do.	0	0	11	0	0	11	0	0	11	0	0	11
FOREIGN STEEL.												
Swedish, in kegs (rolled)	14	0	0	14	0	0	14	0	0	14	0	0
„ (hammered)	16	0	0	16	0	0	16	0	0	16	0	0
English, Spring	19	0	0	19	0	0	19	0	0	19	0	0
Quicksilver, per bottle	6	17	0	6	17	0	6	17	0	6	17	0
TIN PLATES.												
IC Charcoal, 1st qu., per box	1	10	0	1	10	0	1	10	0	1	10	0
IX „ „ „	1	16	0	1	16	0	1	16	0	1	16	0
IC „ 2nd qua., „	1	6	0	1	6	0	1	6	0	1	6	0
IC Coke, per box	1	4	6	1	4	6	1	4	6	1	4	6
IX „ „	1	10	6	1	10	6	1	10	6	1	10	6

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

The Betts Metal.—Infringement.—Betts v. Neilson.—The plaintiff's patent for "a new manufacture of capsules and of a material employed therein," had been taken out for England and Wales in 1849, and prolonged for five years, by decision of the Privy Council, in 1862. Messrs. J. and R. Tennent, manufacturers and exporters of bottled beer, of Glasgow, had been in the habit of covering their bottles with capsules made on the plaintiff's plan, and of sending such bottles to their agents in Liverpool and London for transhipment and exportation. The plaintiff now filed a bill to restrain this alleged infringement. The defendant's case rested first on a *prior user*, consisting in a patent taken out by one Dobbs at the beginning of the century, and which was alleged to anticipate Bett's; second, on the ground that the mere transhipment of the cargo at Liverpool or London, from the Glasgow vessel to that sailing for a foreign port, was not such a user of the invention in this country as to constitute an infringement of which the court could take cognizance. After nine days' arguments, Vice-Chancellor Wood decided in favour of the plaintiff on all issues raised. Anent the first ground, he held that the prior user had not been substantiated, Dobbs's invention having never been applied in practice. Upon the legal question of infringement, the defendants remained owners of the cargo while it was lying in the docks at Liverpool or London, while the capsules, the object of which was to prevent injury to effervescing liquors from the access of air, moisture, or insects, were performing this function by securing the bottles, to the profit of the defendants. Injunction granted, but for England and Wales only.

The Law of Trade Marks.—Stephens v. Peel (March 22).—The plaintiffs sought for an injunction to restrain the defendant from selling or exposing for sale any ink in bottles bearing an imitation of a well-known label affixed to the bottle of the plaintiffs' ink. The inventor of "Stephens's blue-black writing ink" had engraved and used, and his successors still use, a label of the following general description:—The word "Stephens" forms one line of the label, and is printed in large white letters on a ground half red and half white; underneath, and also forming a separate line, are the words "blue-black" in white letters on a blue ground; and again below are the words "writing fluid" in white letters on a red ground. Below is a general description of the ink. The label on the bottles of ink sold by the defendants is in French, with the exception of the words which mainly form the resemblance, and the ink is a French ink made by Messrr. Houssard Jonquet, of Rouen. The labels possess great general similarity, but the imitation on which the plaintiffs' case rests is as follows:—Instead of the word "Stephens" on a ground half blue and half red, the defendant's labels have the words "Steel Pens" on a red ground. Then below are the words "blue black" on a similar ground to that on which the words are printed in the plaintiffs' label. Instead of the words "writing fluid" the defendants used the words (also in white letters on a red ground) "Houssard Jouquet." Vice-Chancellor Wood held that the question was, whether the device used by the defendant in this case was not likely to mislead an incautious retail purchaser. This appeared to him to be clearly likely to be so. He therefore granted the injunction asked for.

Williamson v. the Manchester South Junction and Altrincham Railway Company.—At the last Liverpool Assizes the jury awarded £1,800 damages to the plaintiff for severe injuries received on descending from a carriage at the Loudon-road Station, Manchester, there being no lights at the place. The amount of these damages is one of the highest ever awarded against a railway company.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of the title of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

The Coasting Trade of France is greatly on the decline, owing to the competition of the railways. The following are the total freights conveyed by sea to and from five of the chief ports, from and to other French ports during 1865:—

	No. of tons sent from port.	No. of tons received at port.
Havre	296,000	190,000
Marseilles	196,000	223,000
Bordeaux	155,000	177,000
Rouen	104,000	174,000
Brest	90,000	90,000

The total freight conveyed by sea from one French port to another was 2,223,000 tons in 1865, being 89,000 less than the average of the five years 1860-65.

Progress of Victoria.—The area of this colony is 55,571,840 acres: of these 6,785,225 were occupied in 1865, of which 5,357,962 were enclosed, about 530,19; acres were under cultivation. The population was 77,345 in 1851, shortly before the discovery of gold; in 1865 it was 616,375, including 260,300 persons at the goldfields. The value of the colonial produce exported in '64 and '65 was as follows:—

	1864.	1865.		1864.	1865.
Gold	£6,206,237	£6,190,317	Tallow	£60,230	£15,566
Wool	3,250,128	3,315,109	Hides and skins	102,724	83,?61

The public debt on December 31st, 1865, amounted to £8,733,445.

Exports of Iron and Steel.—The exports of steel and iron of various kinds from the United Kingdom last year were unprecedently large, amounting to 1,681,992 tons, against 1,617,509 tons in 1865, 1,502,964 tons in 1864, 1,640,949 tons in 1863, 1,501,451 tons in 1862, 1,322,694 tons in 1861, 1,442,045 tons in 1860, 1,465,191 tons in 1859, 1,349,058 tons in 1858, and 1,532,386 tons in 1857. If it be said that the increase in the ten years has not been very striking, such a remark cannot be made if the comparison is carried back for a further period of ten years. Thus, in 1856, Great Britain exported 1,438,900 tons of iron and steel, as compared with 1,092,735 tons in 1855; 1,196,663 tons in 1854, 1,261,272 tons in 1853, 1,035,884 tons in 1852, 919,479 tons in 1851, 783,424 tons in 1850, 709,492 tons in 1849, 626,141 tons in 1848, and 549,709 tons in 1847. Great Britain has thus multiplied threefold her exports of iron and steel during the last 20 years. The value of the iron and steel exported last year was £14,829,369, as compared with £13,471,359 in 1865, £13,310,484 in 1864, £13,150,936 in 1863, £11,365,150 in 1862, £10,326,646 in 1861, £12,151,997 in 1860, £12,314,437 in 1859, £11,197,072 in 1858, and £13,603,337 in 1857. In the year 1847 the value of the iron and steel exports was only £5,265,779.

The Isthmus of Darien Canal.—The United States Congress has adopted a resolution extending material aid to American citizens engaged in the survey of a route for a ship canal across the Isthmus of Darien.

The Zuid-Beveland Canal.—The works for barring the Eastern Scheldt having now been taken in hand by the Dutch Government, that part of the river is no longer navigable, and ships are obliged to use the Zuid-Beveland Canal, which was opened last October, with a view to replace the said part of the Scheldt.

Weather Forecasts.—The shipmasters and principal officers belonging to the mercantile marine at Leith have unanimously petitioned the Board of Trade to resume the late Admiral Fitzroy's system of storm signalling until a better can be adopted.

Rock Oil for Steam Fuel.—An experimental trial was recently made at Lambeth, by Messrs. Wise, Field, and Aydon, of their method for burning rock oil in steam furnaces. The oil is allowed to fall through a narrow orifice in a continuous stream (as in the present case the worst kind of creosote refuse was used) about ⅛in. in diameter, or flowing at the rate of about three gallons per hour. As the oil falls vertically, it is met by a superheated steam jet, which blows the oil in a cloud of spray against hot tiles and lime on a coal grate, a coal fire being first used to get up steam for the superheated blast. The apparatus was fitted to the furnace of a Cornish boiler, and, with the consumption of oil stated above, the steam was maintained at a pressure of from 32lb. to 35lb. per square inch, and the engines usually worked by the boiler with the furnace burning coal kept going. The amount of water evaporated was 10 cubic feet per hour for 100 square feet of surface of boiler. The cost of creosote refuse is from 30s. to £2 per ton. Taking the creosote used at 1d. per gallon, the cost of the fuel burned would be 6d. per hour, and the

work done is stated to have been equivalent to a half-hundredweight of the best Aberdare coal, at £1 2s. per ton, the value of which would be rather more than 6d. So far as could be ascertained, 19·5lb. of water were evaporated per pound of oil consumed.

French Iron and Coal.—The total production of iron in France in 1866 is officially estimated as follows:—Charcoal-made iron, 50,400 tons, of the estimated value of £782,880; iron made with two kinds of fuel, 28,100 tons, of the estimated value of £390,200; and iron made with coal, 733,400 tons, of the estimated value of £6,539,000. The coal extraction of France last year was officially estimated at 12,000,000 tons, as compared with 11,300,000 tons in 1865. In 1860, the corresponding extraction was 7,500,000 tons; and, in 1850, it amounted to 4,430,000 tons.

NAVAL ENGINEERING.

Sailing of the Great Eastern.—The *Great Eastern* sailed from Liverpool on March 26, passing the landing-stages shortly before two o'clock. The commencement of her voyage was unfortunately attended with an accident of a very grave character, which resulted in the immediate death of one man, and serious injuries to nine or ten others. When the anchors were being hauled up, a number of men were at the capstan of the starboard anchor, turning it in the usual manner with spokes. The donkey-engine was put on to assist them, when suddenly a pin snapped, the capstan swung round, and scattered the men right and left, the spokes striking them and inflicting various injuries. Several men were taken on shore, one quite dead, whose body was deposited at the dead-house, Prince's Dock; and two, very severely injured, were taken to the Southern Hospital. Others, whose injuries were, no doubt, not so great, remained on board. The vessel has since arrived out in perfect safety.

STEAM SHIPPING.

Extraordinary Despatch.—The screw-steamer *Hibernia*, one of Messrs. Handyside and Henderson's Anchor Line of American Packets, arrived in Glasgow on the morning of the 29th March, with a full cargo of American produce, and was completely discharged and re-loaded on the following evening, having been only thirty-five hours in the port of Glasgow. This despatch shows the anxiety of the owners to keep the advertised time.

The Late Ocean Steamboat Race.—The screw-steamers *Union* and *Hammonia*, on the outward voyage to New York, in March, steamed from Southampton in nine days three hours. The *Hammonia* (Capt. Ehlers) left Southampton one hour before the *Union*, and arrived at Sandy Hook exactly one hour before her. Another instance of such uniform and rapid steaming from Southampton to New York is not, we understand, on record. The average run of the *Union* was 333 miles a day. Both the *Hammonia* and *Union* were recently built by Messrs. Caird and Co., Greenock, both steamers being about the same tonnage and engine-power.

The Steam Navigation of New York has met with numerous reverses during the last ten years, as appears from the following figures. Since 1857, 219 steamships, with an aggregate tonnage of 230,551 tons, and owned in whole or in part in that city, have been lost at sea, broken up, or sold into foreign service. By far the greater portion were lost.

SHIPBUILDING.

Steam Shipbuilding on the Clyde.—Messrs. Scott and Co., of Greenock, have launched a well modelled screw named the *Galvanic*. The vessel is the property of the Belfast Steamship Company, and will be employed as a consort to the *Electric* and the *Magnetic*, plying between Liverpool and Belfast. The steamer's engines, which are direct-acting, will be supplied by the Greenock Foundry Company.—Messrs. Caird and Co., of Greenock, have launched a screw of 2,900 tons, named the *Weser*, for the North German Lloyd Steam Navigation Company. For particulars see our last issue, page 83.—An experimental twin-screw, built some time since by Messrs. M'Nab and Co., of Greenock, has been sold to Mr. Cansh, yacht agent, Birkenhead.

Additions to the Royal Navy.—A return lately issued shows that in the seven years, 1860-66, 105 ships, of 204,905 tons, were ordered to be built, purchased, or converted into ironclads or screws; and 77 ships, of 116,587 tons, ordered to be built before 1860, were launched after that date, making a total addition in the seven years, of 182 ships, of 321,492 tons. In the same period 327 ships, of 273,761 tons, were withdrawn from the Royal Navy by sale, loss at sea, or otherwise, making the net result a diminution of 145 in the number of ships, but an increase of 47,731 in the number of tons. Fifty wooden screw ships, in addition to the above, were ordered to be built in 1860 and 1861, but in the more general adoption of armour-plating they were not proceeded with. Ships removed from the list of sailing ships to that of steamships, or from the list of steamships to that of armour-plated ships, appear on both sides of this account.

Launch of the "Skerryvore."—Messrs. Archd. M'Millan & Son have recently, launched from their building yard at Dumbarton this handsome cutter, which is about 50ft. in length, 16ft. beam, and 7ft. 9in. depth of hold, for the Commissioners of Northern Lighthouses. She is coppered and copper-fastened throughout, and is very well adapted for her intended employment.

MILITARY ENGINEERING.

The Galand Rifle.—Mr. Galand, a Paris gunsmith, has conceived the idea of igniting the cartridge by the summit, and making the cases act upon the projectile by the intervention of a compressible body, so as to overcome its inertia without shock, as if by a spring successively stretched, which, in shrinking, renders all the force stored up within it. In the new arm Mr. Galand fixes a copper cap at the end of a screw acting as a breech. This many-threaded screw enters the chamber sufficiently to form a solid and sure resisting piece. The arm is opened by a slight movement of the hand, and, at the moment of discharge, the copper cap, being very malleable, opens out at the instant of the explosion by the pressure of the gases. The same screw which acts as breech, when unscrewd, easily draws out the copper cap, which has been flattened out into the conical space into which it enters at each manœuvre. It is in part hollow, and contains four pieces of mechanism for percussion of an extreme simplicity. The needle which ignites the charge acts as a detent, a kind of hook replacing the head of the hammer in the action of cocking. To take all the mechanism to pieces, it is only necessary to unscrew a simple bolt. To determine the explosion a pallet inserted into the body of the screw must be pressed by the thumb. The cartridge consists of a small cotton bag, having at its extremity a disc of cotton furnished at its centre with a small quantity of fulminating powder. Five grammes of powder are poured into the bag, a greased wad separates the powder from the ball, and the bag is tied with a ligature. The cartridge leaves no residue whatever after firing. The principal dimensions of the Galand gun are:—Diameter of barrel, 10 millimetres, = 2-5th of an inch; pitch of grooves, 1 turn in 75 centimetres of the barrel; weight of ball 26 grammes (14·7 drams); charge of powder, 5 grammes (2·8 drams). The ball penetrates a deal plank at the distance of a thousand metres.—Abbé Moigno in *Chemical News*.

TELEGRAPHIC ENGINEERING.

The Swiss Telegraph Net, like that of Belgium, is wholly under the control of the State, exclusive of certain wires employed in the service of the railways. The Swiss system now includes 2,130 miles of line, and 3,717 of wire. It has 388 instruments, and 252 telegraph stations were open at the end of the year 1865, besides 28 so-called offices of deposit. It is found that nearly 14 miles of telegraphic line exist in Switzerland to every 100 square miles of country, and that there is one telegraph station for every 10,000 persons. A most important feature of this system is the arrangement between postal and telegraphic authorities, by which money-orders may be sent by telegraph instead of post. An uniform charge of a franc is made for every inland Swiss telegram, each addition of ten words or under being charged 25 centimes extra. A free delivery is made within three-fourths of a mile of the receiving office. If beyond that distance, the message may be sent post-free, or by special messenger, at a charge of half a franc for a mile and a-half. The telegraphic system, as thus conducted, has been found to work as well in Switzerland as in Belgium, and, indeed, the former country shows a larger proportion of telegrams, as compared to letters, than the latter. The number of inland messages sent in Switzerland during the year 1854 was 109,600, and in 1865 a total of more than 364,000 was obtained, which produced a sum of 381,378f. (£15,255 2s. 5d.) In the former year the proportion of telegrams to letters was one to 125, and in the latter year but one to 69. To all appearance this great increase of telegrams is due to the natural conformation of the country, which renders all postal arrangements necessarily slower than those in Belgium, and so increases the advantages of telegraphic communication.

Paper Lightning Protectors for telegraphic lines are now attracting attention. They consist of two well-smoothed brass plates from 25 to 30 square centimetres (3·87 to 4·65 sq. in.) placed one above the other, and separated by a sheet of paper; one of the metal plates is in connection with the line, the other communicates with the earth. As soon as a rather strong tension occurs on the line, sparks pass from one plate to the other, perforating the paper, and the electricity passes into the earth very easily. M. Guillemin proposes to replace the paper by a very thin layer of mica. The mica is a better insulator; it does not absorb damp; it cannot produce carbon, since it is of a mineral character; moreover, its ready cleavage allows of its being split into plates thinner than a sheet of paper. The administration of the telegraphic lines purpose to place, very shortly, a great number of these lightning conductors in places subject to be attacked most frequently by the electric fluid of the atmosphere. Practical trial is the only method by which the modification proposed by M. Guillemin can be appreciated. We hope the results will be favourable.—Abbé Moigno in the *Chemical News*.

DOCKS, HARBOURS, BRIDGES.

A Submerged Tubular Railway Bridge is to be laid across the Mississippi, at St. Louis, Missouri. A bill authorising this construction has just been passed by the United States Congress.

The Bridge on the Niagara River, at Buffalo, N.Y., will be constructed according to Mr. Kennard's designs, in spans of 250ft., supported on piers with iron cylinders filled in with ashlar masonry, and surrounded by cribs loaded with broken stone. The total weight of each pier will be 217 tons. The superstructure will consist of wrought-iron truss girders, and it will carry a railway and road side by side.

GAS SUPPLY.

The Metropolitan Gas Bill.—By the General Gas Clauses Act the maximum dividend of ten per cent. was allowed to all gas companies adopting the provisions of the Act, and the latter were further authorised to make good deficient back dividends by the establishment of a reserve fund. Most provincial gas companies in England are now governed by the Gas Clauses Act. In 1860 the Metropolitan Board of Works procured the passing of an Act by which the ten per cent. maximum was retained, while the application of the reserve fund was limited to a period of three years. The illuminating power was fixed at twelve candles, and the maximum price at 4s. 6d. per 1,000 cubic feet. The companies were allowed the exclusive possession of their respective districts, but compelled to provide gas on demand within their boundaries. In 1866, subsequently to a parliamentary inquiry, the companies agreed to increase the illuminating power from twelve candles to fourteen, and the maximum price was reduced to the present standard of 4s. per 1,000 cubic feet. By the new Gas Bill recently introduced into Parliament, and which is countenanced by the Government, it is proposed that the maximum price of gas shall be 3s. per 1,000 cubic feet, and the dividend limited to seven per cent., except when the price is reduced below the limit fixed by the bill. However, this bill not only meets with a strong resistance on the part of the companies, whose very existence would be jeopardised by its adoption, but is thought by many to be founded on the Transatlantic principle of repudiation, being diametrically opposed to public faith. The ultimate passing of the bill is considered improbable.

RAILWAYS.

Railways in the United States.—Forty years ago the United States had but three miles of railway in operation. They now have 35,341 miles working, and 15,943 miles building. The value of the completed roads is 1,502,464,085 dollars, an average of 40,723 dollars a mile. On an average, four miles of road per day are now built in the United States.

APPLIED CHEMISTRY.

Gilding of Porcelain.—A coating of gold which is brilliant without burnishing may be imparted to porcelain by a mixture prepared as follows:—32 parts of gold are to be dissolved in aqua regia, containing 128 parts nitric, and the same amount of hydrochloric acid, heat being applied. When the solution is complete, 1 and 1-5th part tin, and the same amount of butter of antimony, are to be added; and after heat has been applied, the result is to be diluted with 500 parts of water. Also 16 parts sulphur, and the same amount of Venice turpentine are to be gently warmed, until they form a tough, uniform dark-brown mass, which is to be thinned with 50 parts of oil of lavender. The solution of gold is poured into tins; and the mixture being kept warm, it is to be constantly and gently stirred, until a uniform liquid is obtained. On cooling, the water and excess of acid separate, and the resinous mass thus obtained is to be well washed with water and dried, then thinned with 65 parts of oil of turpentine; and having been heated until it becomes of an uniform consistence, 5 parts of basic nitrate of bismuth are to be added to it; after which it is to be left at rest till it is quite clear. The clear portion may then be poured off, ready for use. It dries quickly on the porcelain, and the gilding is brought out by the application of a high heat.

The Navassa Guano, which is found on the Island of Navassa, situated in the Caribbean Sea, is not, like the Peruvian guano, a product of birds, but a mineral, differing from apatite, inasmuch as it does not contain chlorine and fluorine, but organic matter. A company at Baltimore, U.S., works the quarries, and the following is an analysis of the raw material by Dr. Ulex, of Hamburg:—Moisture, 1·6; organic matter, 10·4; SO_5, 31·2; lime, 34·5; CO_2, 3·3; alumina and peroxide of iron, 19·0; total 100·0. It is stated to be imported into England.—*Polytechnisches Centralblatt.*

On the action of Bismuth on Phosphoric Acid.—When a fragment of bismuth is thrown into glacial phosphoric acid infusion, the metal fuses to a bright globule, from which small flames appear. This phenomenon is sometimes so strong that particles of incandescent bismuth are thrown out of the vessel, forming a shower of sparks. Eventually there remains a spongy mass of bismuth, and a white powder which is phosphate of bismuth. The flames which appear, arise evidently from the phosphide of bismuth, which would be formed, and which decomposes by giving up its phosphorus, or forming phosphoretted hydrogen in contact with the water of constitution of the phosphoric hydrate.—*Zeitschrift für Chemie.*

LIST OF APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF "THE ARTIZAN."

DATED MARCH 7th, 1867.

644 W. E. Newton—Steam hammers
645 J. G. Woodward—Generating steam
646 W. Clark—Actuating fan blowers by steam power
647 E. Lloyd—Treatment of straw, &c., for the manufacture of paper
648 W. Hurrell—Bushings for the bung holes of casks, &c
649 B. Snow—Scissors or shears
650 W. Young and P. Brash—Distillation of bituminous substance
651 W. H. Towers—Process whereby leather, &c., is made hard
652 S. C. Salisbury — Reducing and refining metallic ores

DATED MARCH 8th, 1867.

653 C. Mather—Beating fabrics
654 F. Pope—Locks
655 H. Churchman and F. Braby—Cleaning boots and shoes
656 J. H. Johnson—Glove fastenings
657 J. Turner—Composition for coating the surface of iron, &c.
658 T. Cook—Sewing machines
659 W. R. Lake—Coating paper, &c.
660 G. H. Daw — Construction of cartridges for breech-loading firearms
661 C. Mace—Steam boilers
662 J. Whitaker—Steam boilers
663 M. Henry—Measuring the speed of ships, &c.
664 S. Hawthorn—China and earthenware knobs for locks and latches
665 T. S. Turnbull—Mourning and other lockets
666 J. Horton—Metallic rollers used in preparing cotton, &c.
667 G. Dumler—Lamps for burning petroleum, &c.
668 J. Newman—Tyres for railway and other wheels
669 J. E. Asselin—Needle cases
670 W. Clark—Facilitating the starting of street or horse railroad carriages

DATED MARCH 9th, 1867.

671 A. Field and W. B. Nation—Ornamenting candles, &c.
672 L Tiden—Bearings for railway axles
673 W. S. Lowe—Sizing and dressing machines
674 A. Rupp—Regulating the speed of drying cylinders employed by dyers
675 J. G. Tongue—Bridles and reins connected therewith
676 J. S Gisborne — Protecting the needles of mariners, &c., from local attraction
677 M A. F. Mennons—Breech-loading firearms
678 G. Glover—Lamps for burning naphtha, &c.
679 R D. Napier—Apparatus connected with steam boilers
680 B. Walker and J. F. A. Pflaum—Machinery for crushing stones, &c.

DATED MARCH 11th, 1867.

681 A. Millar—Stamps for marking the prices of goods
682 H. C. Hill—Winding yarn and thread
683 M. Cavanagh—Sash fastening
684 H. A Bonneville — Preserving solutions of certain plants and matters in a concentrated state
685 J. J. Blackham—Brooch and other fastenings
686 W. B Nation—Raising, forcing, propelling, and exhausting fluids and gases
687 A. Kimball—Sewing machines
688 F. Ryding—Baking vulcanite india rubber, &c.
689 P. Duchamp—Stopping bottles
690 J. Pearson—Ball or supply valves
691 J. B. Feuby—Connecting door and other knobs to their spindles
692 E. T. Hughes—Promotion of economy in the combustion of gas and other oils
693 W. Dempsey—Spinning and doubling silks, &c.
694 D. Nicoll—Electric telegraph conductors
695 W. Akers—Horse shoes
696 M. P. W. Boulton—Propulsion in fluids
697 M. Chamberlaine—Washing machines
698 W. Clark—Drying threads and fabrics, &c.
699 M. J. E. Julienne—Bath belts

DATED MARCH 12th, 1867.

700 R. Wilson — Governors of steam and other motive power engines
701 L. C. Sodemau —Fastening and unfastening ladies' stay busks
702 T Burt—Moving mud, &c.
703 H. P. Walker—Valves for steam engines, &c.
704 H. L. Corlett—Buffing springs and parts connected therewith
705 T. Hutton—Producing transparent pictures for exhibition in magic lanterns
706 A. Purkinson and D. Sweaney—Combined slop pail and night commode
707 J. F. Brinjes—Manufacture and reburning of animal charcoal, &c.
708 J. Fox—Filters
709 C. Maschwitz—Taps and valves
710 J. A. Fussell—Hat and coat hooks, &c.
711 W. Trimble—Preparing flax, &c., for spinning
712 W. Hall—Winding and twisting yarns
713 J. L. Norton—Washing and cleansing wool, &c.
714 W. Wood—Machines for tearing up rags, &c.

DATED MARCH 13th, 1867.

715 J. Willcock and S. Mason—Wheel moulding machines
716 W. J. Sleath and J. Hargreaves—Healds employed in looms for weaving
717 M. A. F. Mennons—Breech loading firearms, and cartridges for the same
718 J. Thevenet—Slide valves of steam engines
719 J. Boyd—Looms for weaving
720 T. Walker and T. F. Walker—Measuring the flow of liquids
721 J. Hamilton—Artificial material for producing gas for illuminating purposes
722 W. E. Newton—Ventilation of theatres, &c.
723 F R. A. Glover—Tackle for and the manner of letting down and weighing anchors on board ship
724 M. Henry—Supplying beer, &c.
725 G. Rumbelow and H. Kendall—Rolling land
726 W. Wootton—Instruments used in the sockets of candlesticks to secure candles therein
727 J. Griffith—Applying wind power for working ships' pumps
728 B. Platt—Manufacture of chloride of lime
729 J. C. Morrell — Apparatus applicable to dry closets, &c.
730 W. Esplen and J. J. B Bland—Signalling apparatus, &c.
731 M. F. Halliday—Breech-loading firearms
732 E. Lee—Producing pictures, &c., upon glass and other materials

DATED MARCH 14th, 1867.

733 W. Read—Boring and excavating coal, &c.
734 H. Smith — Preparing turnips and mangel worzel for the food of animals
735 S. Clarke—Candlesticks
736 J. B. Dancer—Instruments for ascertaining the speed of machinery
737 W. G. Blagden—Extracting silver from alloys of zinc with lead
738 P T. Goodwin—Retorts for re-burning animal charcoal
739 J. Ferguson—Applying screw propellers
740 W. E. Newton—Boxes for containing, preserving, and transporting butter, &c.
741 W Hamer and J. Davies—Supplying heated air to furnaces and fires, etc.
742 J. P. Baragwanath — Cramping and lifting apparatus

DATED MARCH 15th, 1867.

743 J. Keymer and W. Whitehead—Dyeing and printing
744 J. R. Parkinson — Varnish to be applied to healds of looms for weaving, etc
745 J. Westwood and R. Baillie—Protecting the outer surface of iron ships from corrosion, etc.
746 W. H Graveley and J. Ewing—Steam cooking and baking apparatus
747 E. P. Plenty—Steam engines for the propulsion of boats and other vessels
748 J. H. Johnson—Dyeing carded wool or hair
749 P Crause—Propelling boats, etc.
750 W. E. Newton—Spinning machinery
751 A. V. Newton—Bale tie
752 G Smith—Preparation of soap
753 N. Thompson—Connecting the ends of pipes and tubes
754 J. P. Harper — Safety apparatus for mining cages, etc.
755 W. R. Lake—Rotary engines and pumps

DATED MARCH 16th, 1867.

756 T. Cowburn — Safety-valves, etc., for water heaters and steam generators
757 T. Dunn—Boilers, etc., for generating steam and evaporating liquids
758 E. Nougaret—Pouncing hats
759 J. Milner—Slide valve gear for steam engines
760 W. R. Harris—Fastener for piecing, driving, and other belts
761 M. A. F. Mennons—Breech-loading firearms
762 J. Grundy—Prevention of smoke
763 J Kennedy—Treating cast-iron articles
764 G. Hutson—Steering apparatus
765 R. Canham—Sharpening knives, etc.
766 J. Hickisson—Preparation of biscuit, etc.
767 S. Holness—Rotating brushes, etc.
768 T. Shedden—Breech-loading firearms
769 A. V. Newton—Breech-loading firearms
770 A. J. H. Elliot—Producing and applying a self-acting mechanical power for working machinery
771 E. E. Allen—Steam engines and boilers
772 J. Shand—Steam fire engines and boilers

DATED MARCH 18th, 1867.

773 W. H. Bailey—Travelling trunk, bath, and cradle combined
774 J. Smith—Cleaning waste and other substances
775 T. W. Nicholson—Lithographic stone grinding and other apparatus
776 F. H. Wenham—Heated air engines
777 H. J. Newcombe Warming buildings
778 H. Sims—Apparatus to be used in connection with pianofortes
779 W. H. Parsons—Setting boilers, etc.
780 D. Ellis and M. Hillas—Weaving
781 J. Smith—Gun locks
782 A. W. Moore and E. McNeal—Spring shank applicable to boots and shoes

DATED MARCH 19th, 1867.

783 J. Robinson—Steam boilers and engines
784 E. Harvie—Raising carriage heads
785 C. F. Cooke—Safety valves for steam boilers
786 J. C. H. Stevier—Ordnance
787 F. Gregory—Machinery used in breweries and distilleries
788 A. H. Hart and W. Parry—Treating sewage
789 C. Allhusen—Treating small pyrites, etc.
790 J Hislop—Removing carbon from gas retorts
791 M. Semple—Warming and ventilating buildings
792 A. V. Newton—Sewing machines
793 J. M. Clements—Ironing and other machinery
794 A. S. Cameron—Construction and arrangement of the connections and casings of protected safety valves for steam generating apparatus
795 J. H. Johnson—Printing skeins of silk, etc.
796 T. Aveling—Steam rod rollers
797 W. McAdam and S. Schuman—Casing for protecting bottles, etc.
798 E L Sturtevant—Breech-loading firearm
799 W. Clark—Disaggregation of china grass, etc., for the production of threads, fabrics, and pulp for paper
800 J. Portlock—Operating the extractor of breech-loading drop guns

DATED MARCH 20th, 1867.

801 R. H. Collyer—Treating flax, etc.
802 P. T. Goodwin—Driving revolving retorts and cylinders
803 J. W. Yates—Handles of spades, etc.
804 T. K. Mace—Securing door and other knobs to their spindles
805 M. A. F. Mennons—Central fire cartridges for breech-loading firearms
806 S. M. Tyler—Sewing machines
807 G. A. Laurent—Preventing accidents on railways
808 B. J. Smith—Protecting watches in the pockets
809 J. R. Swan—Steam boilers
810 G. Bischof—Coating metals, etc.
811 G. Chambers—Exhibiting cloths and fabrics
812 J. Leeming—Looms for weaving

DATED MARCH 21st, 1867.

813 D. Y. Stewart—Core, etc., for casting iron pipes and similar articles
814 G. E. Marchisio—Preparation and application of isolating compositions for the protection of metallic surfaces from oxidation, etc.
815 J. Booth—Textile fabrics, etc.
816 J. H. Simpson—Printing telegraphs
817 H. Clifton—Coolers for wine
818 H. Clifton—Refrigerators, etc.
819 J. Greenshields—Compound of materials to be used for the production of illuminating gas
820 W. Clark—Central fire cartridges
821 L. Latter—Brakes from common road carriages
822 J. A. Limbert—Raising, lowering, and moving heavy bodies
823 W. Lorberg—Urinals, etc.
824 W. E. Newton—Chronometers, etc.
825 H. W. Hart—Producing indestructible photographic pictures
826 W. D. Player—Covers for the tops of bottles
827 G. Haseltine—Steam heating and ventilating apparatus

DATED MARCH 22nd, 1867.

828 W. R. Lake—Separating the grounds from the liquid in making coffee
829 C. Kauffmann—Collars
830 G. Cross and R. Evans—Furnaces for evaporating brine, etc.
831 P. Dickenson—Fences, etc.
832 W. W. Gibson—Decorticating aerials, etc
833 J H. Wiuder—Rotary pump for raising fluids
834 G. Little—Combing cotton, etc.
835 E. S. Tucker—Globular and other forms of glass for ornamenting mirrors, etc.
836 J. Whitley—Stop valves for steam and water
837 J. Lawson—Spinning flax, etc.
838 G. T. Bousfield—Manufacturing flour.
839 G. Adams and W. T. Whiteman—Printing and indenting portions of railway tickets, etc.
840 S. Sedgwick—Rolling spikes
841 J. Spencer—Treating flax and hemp

DATED MARCH 23rd, 1867.

842 W. Wilde — Electro-magnetic and magneto-electric induction machines
843 W. H. Rayner and J. T. Heath—Shoulders of the blades of knives, etc.
844 R. Duncan—Cranes
845 J. H. Soller and E. Barber—Umbrellas and parasols
846 J. Gamgee and A. Gamgee—Preservation of animal and vegetable substances
847 E. Watteeu—Nut tapping machine
848 L. Horsfield — Obtaining and giving motive power
849 E. Edwards—Photographic pictures, etc.
850 W. J. Hanson—Printing yarns
851 C. M. Hulland—Points and crossings of the permanent way of railways and tramways
852 W. Busfield— Spinning and twisting fibrous substances
853 J. G. Tongue—Reins for horses
854 J. G. Tongue—Skipping hoops
855 G. T. Bousfield—Extinguishing lamps
856 J. Betteley—Ships' sheathing

DATED MARCH 25th, 1867.

857 T. Pebardy—Stays for the human body
858 H. Fassmann—Metal bands for securing bales of cotton, etc.
859 G Davies—Rotary digging machines, and teeth for the same
860 W Matthews—Draining mines
861 J. H. Johnson—Treatment of wool, etc.
862 R. Higgins—Cultivating land, etc.
863 A. Wyley—Breech-loading firearms
864 W. E. Newton—Cutting channels in stone, etc.
865 A. Parkes—Coating metal tubes and rods
866 W. Clark—Breech-loading firearms and cartridges for the same

DATED MARCH 26th, 1867.

867 T. Wrigley—Furnaces or fireplaces
868 W. Seaton—Permanent way of railways
869 A. S. Stocker—Stoppers for bottles, etc.
870 J. Saxby—Locking and actuating the locking and interlocking gear for regulating the action and movement of railway points and signals in relation to each other
871 G. Davies—Steam and vacuum gauge
872 A. C. Henderson—Cleansing wool previous to combing the same
873 J Hesse—Means of securing buttons and button holes, etc.
874 E. O. Greening — Iron and wire continuous fencing
875 A. F. Langin—Safety carriage
876 W. R. Lake—Screws
877 T. Unsworth—Banding for driving the spindles of machines used for spinning, doubling, and twisting cotton, etc.
878 J. Toussaint—Uniting cork and leather either separately or combined
879 J. S. Newton—Apparatus for communicating from passengers to guards in trains, etc.
880 J. Wycherley—Manufacturing watches
881 H. G Riggs—Locks for firearms
882 W. E. Newton—Valve gear of steam engines
883 E. B. Bigelow—Looms for weaving
884 G Hookham—Projectiles for rifles
885 R. Morland—Construction of floors and rooms for buildings
886 G B. Daisethorpe—Getting coals and other minerals, etc.
887 C. E. Sch— Construction of posts, etc.

DATED MARCH 27th, 1867.

888 H. Sharp and F. W. Webb—Manufacture of iron and steel by the Bessemer process
889 J. M. Jonsir—lice outside Venetian blinds
890 C. E. Brown and —Propelling vessels, etc.
891 E. W. Shirt—Planeing and other edge tools
892 G. R. Postlethwaite—Screw nuts and washers
893 R. Howse—hot air stoves for blast furnaces
894 H. Fassman—Hardening metallic surfaces
895 J. M. Lauterbach—Setting razors
896 A. Findlay—Fastenings
897 J. Brocklehurst and C. Cornes—Reversing the motion of steam or other motive power engines
898 S. W. Worssam—Cutting wood
899 A. Turner and W. E. Newton—Carpets, etc.
900 L. Foinquin—Envelopes
901 J. Werndl—Breech-loading firearms

DATED MARCH 28th, 1867.

902 A. Mackenzie and S. Robinson—Cisterns for preventing waste of water
903 W. R. Dawson and J. E. Davies—Covering and protecting ships, etc.
904 W. B. Nation—Engines worked by steam
905 J. Arnold and G. Braid—Communication between a railway station and the person in charge of a train at a distance
906 J. Grundy—Fire bars employed in furnaces
907 W. Crighton—Preparation of cotton
908 C. D. Abel—Optical telegraph
909 T. Roper—Iron and steel furnaces
910 F. N. Taylor and J. Lodge—Twisting yarns
911 D. Foster and R. Cooke—Casting of Bessemer steel hoops for the tyres of railway wheels
912 W. Clark—Saddle stirrups
913 W. Clark—Firearms
914 W. Wood—Engines and machines for washing beating, and reducing rags, etc., into paper pulp and fibres for cloth
915 M. P. W. Boulton—Receiving motion from fluids, etc.
916 N. Thompson—Construction of lootts, etc.
917 G. A. Buchholz—Manufacturing and assorting semolina, etc.
918 J. Howard and E. T. Bousfield—Cutting and spreading grasses
919 W. R. Lake—Concentrating the extract of bark for tanning
920 W. R. Lake—Obtaining the extract of bark for tanning

DATED MARCH 29th, 1867.

921 J. H. Johnson—Drawing off wines
922 E. H. Aydon and E. Field Smoothing and otherwise treating iron
923 J. G. Tongue—Lace, warp, etc.
924 P. Shaw—Air engine
925 K. Barnea — Heating water for feeding the boilers of condensing steam engines
926 J. A. Simpson—Construction of umbrellas and parasols
927 W. Easterbrook — Actuating and controlling railway points and signals
928 E. Cauton—Counting and controlling cock for liquids
929 M. Henry—Wind musical instruments
930 A. Barff and J. Kidd—Utilising the illuminating properties of petroleum, etc.
931 W. B. Hilliard—Skates
932 G. Davies—Decoration of metals
933 W. Clark—Manufacture of manure
934 W Wood—Preparation of fibre from rags
935 J. Bird and J. Bird—Artificial fuel
936 E. W. Ball—Gas fireplaces, etc.
937 J. Wolverson—Locks and keys
938 W. Bywater—Effecting the drawing, spinning, twisting, and laying of hemp and flax
939 W. Gadd and L. Baillon—Boot elastic web, etc.
940 B. Farmer and T. Balmforth—Steel bells

DATED MARCH 30th, 1867.

941 R. Canham and F. W. Kreut—Cure of smoky chimneys, etc.
942 J. E. Ward—Coverings for the head
943 E. S. Jones—Rowing boats on water
944 T. Prideaux—Blast furnaces
945 J. Macnee—Movable hoods for carriages, etc.
946 S. M. Grover—Doubling cotton, etc.
947 W. H. Woodbury and R. H. Ashton—Means of producing designs upon paper
948 R. H. Collyer—Treatment of flax, etc.
949 J. Fleming — Bending and circling metallic plates
950 S. Lilley—Fog signals for use on railways, etc.
951 J. J. McComb—Coupling telegraph and other wires
952 W. E. Newton—Manufacturing ice, etc.
953 W. E. Newton—Hydraulic engine for obtaining motive power
954 W. Clark—Manufacture of bricks, etc.
955 G. Higginson—Producing opaline pictures into china, etc.
956 H. A. Bonneville—Hanging ships' rudders
957 H. A. Bonneville—Improved lid
958 H. A. Bonneville—Making brooms
959 J. Raudall and C. Adnoes—Actuating fog signals on railways
960 F. Hahn—Manufacture of gunpowder
961 F. Hahn—Breech-loading needle guns
962 F. J. Manceaux—Firearms
963 J. Whitworth—Firearms and cartridges

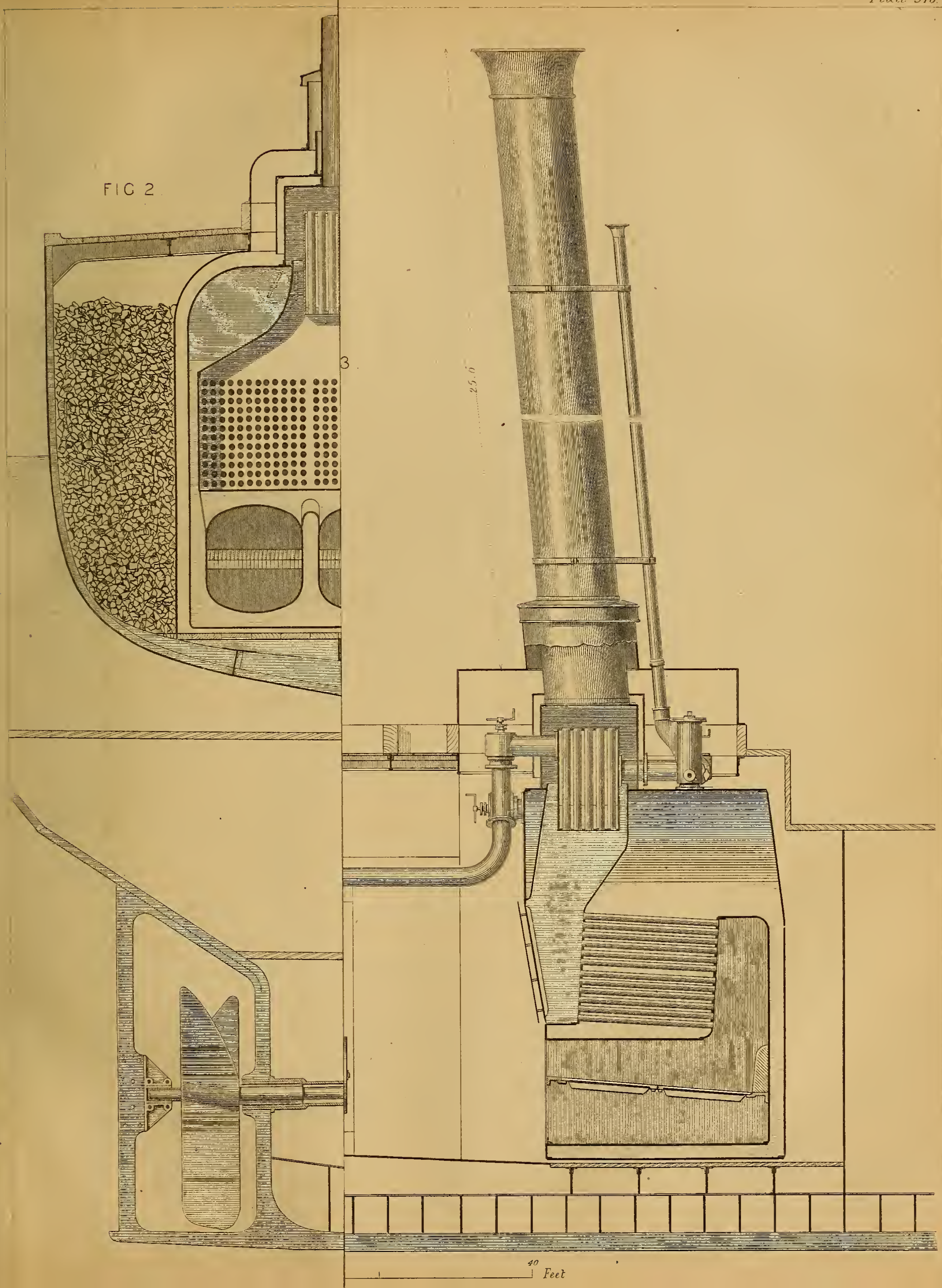
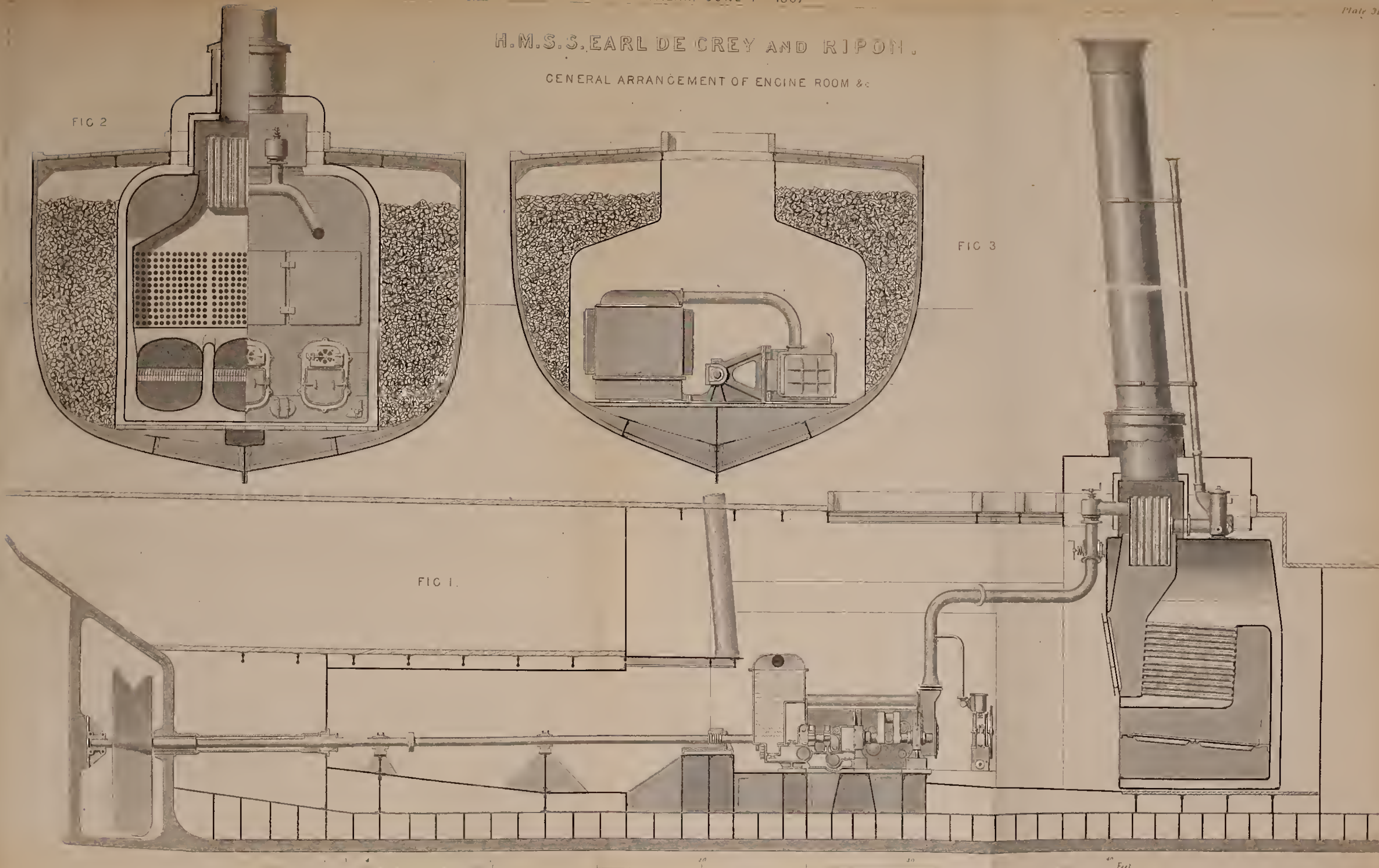


FIG 2
3
25.6
40
Feet

H.M.S.S. EARL DE GREY AND RIPON.

GENERAL ARRANGEMENT OF ENGINE ROOM &c



THE ARTIZAN.

No. 6.—Vol. I.—Fourth Series.—Vol. XXV. From the Commencement.

1st. JUNE, 1867.

THE INTERNATIONAL EXHIBITION OF 1867.

In the April issue of The Artizan we gave a general description of the building of the Paris Exhibition, accompanied by a plan showing the manner in which the whole ground included between the Seine river and the Avenues de la Bourdonnaye, de la Motte-Piquet and de Suffren has been portioned out. We now proceed to give some further particulars, both of the edifice in which this year's world's fair is being held, and the general organisation and arrangement of the latter.

A comparison of the Exhibition of 1867, with the two or three scores of international, national, provincial, regional and "special" exhibitions that have preceded it since 1850, would doubtless be highly interesting; yet the most summary retrospect of this kind could not but far exceed the space we have at our command. We propose, therefore, to confine ourselves to a glance at the four *universal* Exhibitions of 1851, 1855, 1862, and 1867, with regard to the covered and uncovered areas occupied by each of them.

1st. Great Exhibition of 1851, held in Hyde-park, under the auspices of the late Prince Consort:—

Space occupied: 2,300ft. long × 500ft. wide = 1,150,000 square feet, or 26½ statute acres.

Length of building: 1,850ft.

Available space: On the ground floor, 772,784 square feet.

In the galleries ...... 217,100 „

Total .... 989,884 square feet.

Area roofed in, about 799,000 square feet = 18⅓ acres.

2nd. Universal Exhibition of 1855, held in the Champs Elysées, Paris:—

Extreme length	1,168 metres		=	3,937ft.
Extreme width	27	„	=	88½ft.
Palace of Industry	50,737*	sq. metres	=	12.6 acres.
Annexe	41,540	„	=	10.4 „
Panorama and outlying buildings ...	9,026	„	=	2.0 „
Palace of Fine Arts	16,150	„	=	4.0 „
Area roofed in.....................	117,453	sq. metres	=	29 acres.
Gardens and enclosed grounds	22,087	„	=	5½ „
Total space covered..............	139,540	sq. metres	=	34½ acres.

3rd. International Exhibition of 1862, held at South Kensington:—

Length of building .... 1,150ft.
Width of building .... 500ft. } with one upper storey.

2 Annexes: Length .... 945ft.
Width............ 200ft. } each.

Total space occupied by Exhibition and Royal Horticultural Society's Gardens:—

1,710 ft. long × 1,150ft. wide = 1,966,500 sq. ft. or 45 statute acres.

Area of Exhibition roofed in.........	988,000 sq. ft.	=	26.6 acres.
„ unroofed	35,000 sq. ft.	=	0.8 acres.
Total area of Exhibition.........	1,023,000 sq. ft.	=	23.4 acres.

* Equivalents:—
1 metre = 3.28ft.
1 sq. metre = 10.76 sq. ft.
1 statute acre = 43,560 sq. ft. = 4,046.71 sq. metres.

4th. Universal Exhibition of 1867, held in the Champ de Mars, Paris.

Total space occupied:—

Length .... 960 metres.
Width............................ 470 „
Area .... 451,200 square metres = 111½ acres.

Dimensions of building:—

Total length .... 497·60 metres.
Total width .... 387·60 metres.
Radius of each quadrant 190 metres.

Oblong central portion 110 m. × 380 m. = 41,800 sq. metres.
Total area of four quadrants .... 113,412 „

Aggregate area of building .... 155,212 „ = 38½ acres.*

This, of course, does not include the area of the numerous outlying buildings, the International Club, Theatre, &c., which cannot be estimated at less than 20,000 square metres, or about 5 acres.

Summary.

Exhibition of	Total space covered.	Available space.
	Acres.	Acres.
1851	26½	22¾
1855	34½	29
1862	45	23½
1867	111½	43⅓

It will thus be seen that the Paris Exhibition of 1867 is by far the largest in area of all the international exhibitions ever held in Europe. In most other respects, however, it is neither superior nor inferior to its three predecessors. Sir Joseph Paxton's Crystal Palace was in itself a work of art; whilst neither Messrs. Viel and Desjardin's *bâtisse* of the Champs Elysées, nor Capt. Fowke's huge structure in Cromwell-road came up to the standard of architectural taste. But in the Paris Exhibition building we should say that style and elegance have been entirely sacrificed to convenience and expediency; and if, as some worshippers of the past will have it, want of taste forms the leading characteristic of our age of industry, the "Gas-holder" of the Champ de Mars might be a fitting representative and landmark of this age. Let us hope that the designers of the buildings for future exhibitions of this kind will pay more regard to the old axiom:—

Omne tulit punctum qui miscuit utile dulci,

and not entirely exclude taste and elegance for the sake of convenience and utility.

One great and most important redeeming feature is perceptible in the general arrangement of the "exhibits." In all previous cases, the products of the various nations were always kept separate and distinct from each other (with the sole exception of machinery and mechanical implements) and the unmethodical distribution of the space did not permit of an actual and effective comparison of the several articles, as manufactured in

* This figure comprises the area of the central garden, which is 52·5 metres long by 163 metres wide = 7,981 square metres, or nearly 2 acres.

different countries. The organisers of this year's exhibition have steered clear of this radical defect, in a manner which bespeaks great skill and acumen on their part. Whilst the whole of the space has been portioned out to the various nations by means of radial or cross divisions of the building, a juxtaposition of their artistic and industrial products is likewise effected by conveniently arranging them in groups, to each of which an annular space or gallery is devoted. In traversing any one of these, the student or visitor may now judge, almost at a glance, to what extent any branch of industry has developed itself, what state of perfection it has attained in any country of the world, and in how far the various nations are superior or inferior to, in advance or in arrear of, each other, in any department of science, art, or industry. The ten groups comprise altogether 95 classes; it would not, in our opinion, be difficult, nay, we think it most desirable that means should be devised to so increase the number of groups and reduce the number of classes as to suppress the distinction between them. The Exhibition of 1862 contained but 35 classes, and those we deem more than sufficient. By putting side by side the various articles of, say, 25 or 30 groups or classes, the system of "juxtaposition" might be carried through far more thoroughly and efficiently than has been the case this year. The division of each class into two or three sub-classes would involve less inconvenience and yield far greater advantages than the method now used in Paris. However, let us repeat that the latter method is most decidedly a step in the right direction, and the principle of which will, we hope, never again be departed from in future international exhibitions.

In Plate 314, issued with THE ARTIZAN for April last, we gave a general plan of the whole of the building and grounds. With a view to better illustrate the construction and arrangement, we give now, on page 123 of our present number, a sectional plan of the building proper, and on page 124 a radial section of one of its four quadrants. In both these views, the main dimensions are inscribed in French measurements. The plan has been drawn to a scale of 1 to 2,304, corresponding to the metrical scale of about 0·44 millimetre to the metre; the radial section to twice that size (*i.e.* 1 : 1152 = about 0·88 millimetre to the metre). In both views the letters of reference denote the various compartments and annular galleries, as explained on page 124. Of the columns supporting the construction, the round ones are marked in dots in the sectional plan, whilst the crosses (×) denote those of square cross section.

If we compare the figures in the exhibitors' column with those of the London Exhibition of 1862, we find the cases of Great Britain and France nearly reversed. The United Kingdom with its colonies musters but 3,609 exhibitors in 1867, against 10,277 in 1862; whilst France was represented by not more than 3,636 exhibitors at South Kensington, whereas this year the number amounts to 11,645. Of the other principal countries Belgium counted 862 exhibitors in 1862, against 1,448 in 1867; North Germany 2563 in 1862, against 2,206 in 1867; South Germany 563 in 1862, against 1,182 in 1867; Austria 1,410 in 1862, against 3,072 in 1867; and the United States 113 in 1862, against 778 in 1867. The data for 1862 do not include the number of exhibitors in the Fine Arts Department. It is obvious, however, that these figures cannot by any means be considered as criteria of the progress and development of industry in any one of the countries quoted. A certain indifference and apathy, which is easily accounted for, prevented many of the principal manufacturers, both of England and other European countries from taking part in this year's "competitive examination;" and in Central Europe especially last year's war has wrought great changes in the organization of trade and industry, and to a considerable extent checked the *entrain* of manufacturers. On the other hand, the civil war in America was at its height in 1862, and the United States Congress had voted no grant towards proper representation at the London Exhibition; whereas, in 1867, Transatlantic industry having recovered from its wounds by two years' peace, and being supported by a liberal appropriation of funds, may compete with the old world on much fairer terms.

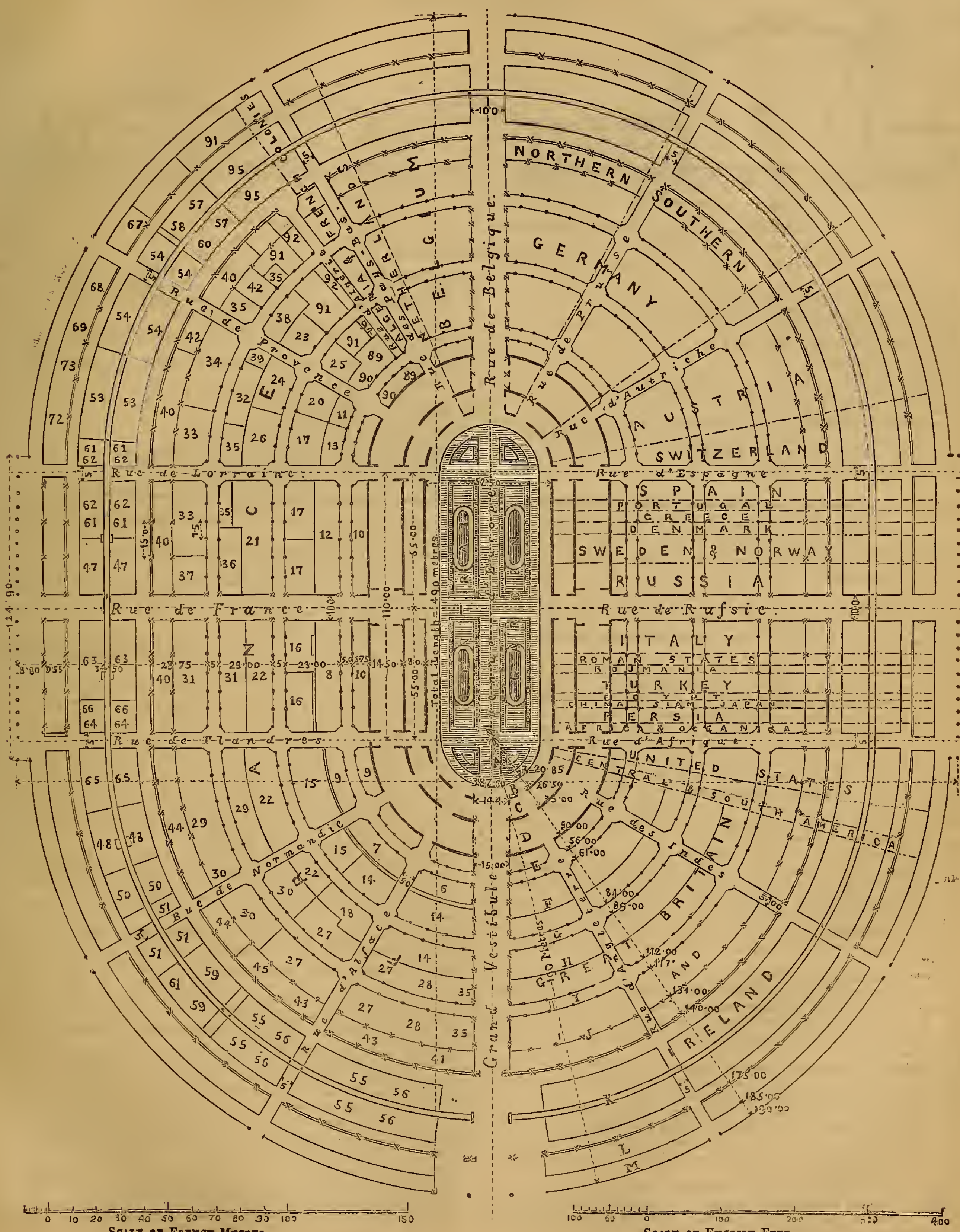
The following table, compiled from official sources, shews the aggregate space allotted to the various nations in the building proper (not including, of course, the space occupied by each of them in the Park, the Horticultural Gardens, and the Isle of Billancourt), and the total number of exhibitors belonging to each of the countries represented.

COUNTRIES.	Space allotted to each country.	Number of Exhibitors of each country.
	Square metres.	
France, Algeria, &c.*	63,640·88	11,645
Netherlands*	1,995·51	504
Grand Duchy of Luxemburg	6·60	10
Belgium	6,993·10	1,448
North Germany †	12,765·27	2,206
South Germany ‡	3,963·03	1,182
Austria	8,362·58	3,072
Switzerland	2,854·12	986
Spain *	1,768·37	2,071
Portugal *	765·37	1,026
Greece	707·37	892
Denmark *	1,016·50	283
Sweden * }	1,930·14	602
Norway }		387
Russia	6,060·70	1,392
Italy	3,459·37	3,992
Roman States	620·41	140
Roumania	560·83	} 4,499
Turkey	1,525·32	
Egypt	415·38	70
China, Japan }	1,447·57	72
Liu-Kiu, and Siam }		24
Persia	155·50	13
Tunis }	1,096·87	47
Morocco }		20
United States	3,944·74	778
Brazil }		1,073
Central and South America }	1,016·45	143
Sandwich Islands }		31
Great Britain and Ireland *	21,059·87	3,609
Vestibule	2,683·14	
Refreshment Rooms & Miscellaneous	935·47	
Total	151,750·46	42,217

The 10 groups and 95 classes were given in THE ARTIZAN for December last, and are, moreover, marked in the general plan, plate 314. Most articles comprised in the 73 classes of groups I. to VII. are contained within the building, whilst those of Class 74 to 95 (Groups VIII. to X.) are distributed in the grounds. Group VI. comprises in Classes 47 to 66 the articles belonging to mining, engineering, and mechanical industry, which, in 1862, occupied the western and a portion of the eastern annexe. The products contained in this group being, of course, the most interesting to the reader of THE ARTIZAN, our future accounts of the Paris Exhibition will be chiefly devoted to this group in general, and some of the most prominent of the mechanical objects contained therein, in particular.

* Including Colonies.
† Comprising Prussia, Saxony, and the other States of the North German Confederation.
‡ Comprising Bavaria, Wurtemberg, Baden, and Hesse-Darmstadt.

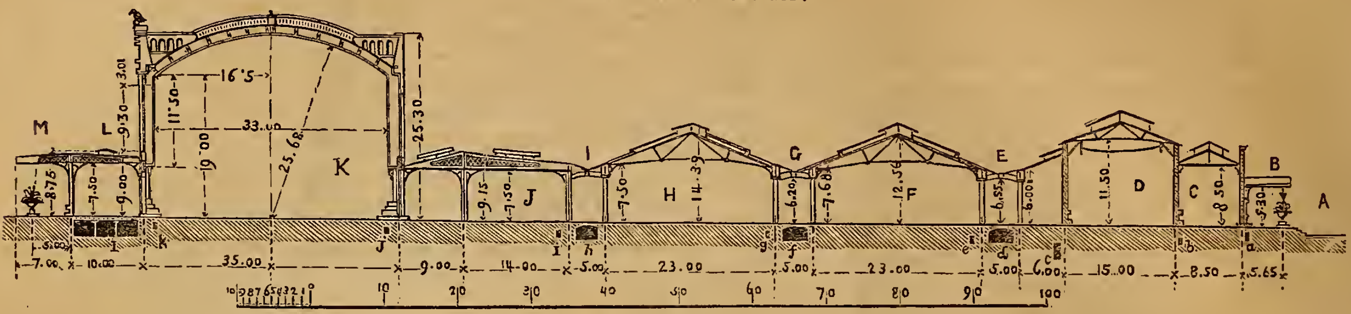
Fig. 1.—Sectional Plan.



Scale of French Metres.

Scale of English Feet.

Fig. 2.—Radial Section.



Letters of Reference.

A. Central Garden.
B. Inner Circuit (*promenoir intérieur*).
C. Archæological Museum (History of Labour).
D. Gallery of Fine Arts (Group I.)
E. Gallery of Liberal Arts (Group II.)
F. Furniture (Group III.)
G. Furniture Gallery.
H. Wearing Apparel and Textile Fabrics (Group IV.)
I. Gallery of Wearing Apparel.
J. Raw Materials and unrefined Products (Group V.)
K. Gallery of Labour—Machinery Department, &c.—(Group VI.)
L. Gallery for Articles of Food (Group VII.)
M. Outer Circuit (*promenoir extérieur.*)

a. Drain; bottom, 1·89 m. below ground; diameter of semicircle, 0·30 m.
b. Ditto, ditto.
c. Sewer; bottom, 4·20 metres below ground; height, 1·55 metre; diameter at top, 0·70, at bottom 0·50 metre.
d. Ventilation Gallery, 3·00 metres wide × 2·36 metres high.
e. Drain, like *a.*
f. Ventilation Gallery; 2·50 metres below ground at bottom; 3·00 metres wide at × 2·03 metres high.
g. Drain, like *a*; 1·89 metre below ground.
h. Ventilation Gallery, like *d.*
i. Drain, like *a*; 1·61 metre below ground.
j. Drain, like *a*; 1·38 metre below ground.
k. Triple Gallery of Ventilation, each division like *f.*
l. Drain, like *a*; 1·03 metre below ground.

MACHINERY AT THE PARIS EXHIBITION.

The machinery at the Paris Exhibition is now getting into something like working order, although there still remains a great deal to be done to complete arrangements.

The gallery assigned to Group VI. (apparatus and processes used in the common arts) differs essentially from the others, and forms a ring or belt 3,936ft. in length, 115ft. in breadth, and 82ft. in height, and here are placed the machinery, tools, &c., used in the various industries of almost every country in the world.

The arrangements for ventilation are nearly completed, and partly at work. They consist in a system of injecting compressed air into a network of radiating and concentric galleries beneath the flooring, and by this means fresh air is drawn in from the outside down the sixteen air shafts at the end of the radiating galleries and distributed throughout the building by air gratings. The air is compressed by means of four engines, of 105 nominal horse-power, and supplied to sixteen jets corresponding with the sixteen radiating galleries through pipes varying from 1ft. to 2ft. in diameter, with a speed of 6ft. 6in. per second, which amounts to 24,700,000 cubic feet per hour of fresh air diffused throughout the building. The quantity of air passing from this jet is regulated by means of a disc, the maximum opening being 130 square centimetres in area.

The first is a portable engine one by Messrs. Farcot and Sons, situated nour the Porte-Rapp. It is of fifteen nominal horse-power, and drives two air fans or ventilators, by M. Perrigault, supplying two air jets. The boiler of this engine is constructed on the system introduced by this firm. It consists of two barrels placed one above the other, and connected together by cylindrical water-ways. The lower barrel contains the fire-grate and tubes, and means are provided that they may be easily drawn out for the purpose of cleaning.

The second, situated in the Belgian boiler-house, is a horizontal engine, by Messrs. Gargan, working three exhausting cylinders, 2′ 8″ in diameter, with 2′ 4″ stroke; it is of 25 horse-power, and supplies four air jets.

Two large fans by M. Perrigault, supplying four air jets, requiring about 25 horse-power, are driving from the shafting in the machine gallery in the Austrian section.

The fourth, and principal blowing engine, of 40 horse-power, by MM. Gauthier and Phillipon, supplies the six remaining air-jets. It is situated in a building in the park outside the English section.

The cylinders are horizontal, and are connected by driving belts with the two blowing cylinders, 4ft. in diameter, with 2′ 8″ stroke.

The boilers for supplying steam to the various engines in the building are placed in nine buildings corresponding with the nine chimney-shafts, 98ft. in height, situated in the park.

Beginning at the grand entrance, and on the right hand, is the open ornamental boiler-house, with terra cotta columns, containing the boilers that generate steam for moving the machinery in the British section, and described in the April number of The Artizan. Messrs. Galloway's three boilers seem to be working well. Green's patent fuel economiser has lately been got to work.

The second is a neat building, containing boilers by M. Flaud, of Paris, situated on the left of the Porte-Suffren.

The third, situated between the Porte-Suffren and the main entrance from the Ecole Militaire, contains two 80 horse boilers, by Messrs. Farcot and Sons, of St. Ouen. They are constructed on the same system as that described above for driving the ventilators.

The fourth, on the right hand on entering from the Ecole Militaire, contains two 50-horse boilers, by Petrey-Chandois, of Liége, for supplying steam to the engines in the Belgian section.

The fifth contains a 30-horse portable tubular boiler, by Coster, of Paris, and another by Boyer, of Lille, which supplies steam to the horizontal engine of 30 horse-power, by the same maker, in the French section.

The sixth, situated in front of the Post-office, contains a tubular boiler, from the Usine de Graffenstaden, which supplies steam to the 35-horse engine by the same company; also, a boiler by Quillacq, of Anzin, which furnishes steam to the engines by the same maker in the building.

The seventh contains two 40-horse boilers, by MM. Chevalier and Duvergier, of Lyons. The heating surface of each is 645 square feet. It supplies a horizontal engine, by the same makers, of about 45 nominal horse-power. The coal used is from Mons.

The eighth contains a 75 nominal horse boiler, by Meunier, of Lille, which supplies steam to a 60-horse horizontal engine, by Le Gavrian.

The other is by Laurens and Thomas, of Paris, and supplies the overhead beam engine, by Lecouteux, of Paris. The coal used is from Anzin.

The ninth, and last, contains a tubular boiler of 80 nominal horse-power, by M. Powell, of Rouen, which supplies steam to two overhead beam engines, by the same maker, on Woolf's principle of high and low pressure cylinders.

Except in a few isolated cases, such as in the Swedish, Spanish, &c., departments, the whole of the motive power is supplied by these boilers. In these departments power is supplied by two Lenoir gas engines of about three horse-power each. In the Roumanian section a two-horse gas engine is at work, and in the French department there are also two half-horse engines, one of which drives a small printing press.

Entering the building by the Porte d'Iéna, on the right is the British section, with the pyramid representing the amount of gold that has been exported from the colony of Victoria during the last fifteen years; and around this post of honour are arranged the four steam cranes by Messrs. Shanks, Russell, Appleby Brothers, and James Taylor, of Birkenhead, which did such excellent service in unloading British goods up to the opening. Here they will remain till their services are required at the closing of the Exhibition.

Near these are exhibited the models of apparatus and machines illustrating the arrangements adopted by the Post-office authorities.

The models of the railway mail carriages in use by the limited night mail train on the London and North Western Railway, showing travelling post-

office, with mail-bag apparatus for receiving and delivering mail-bags at stations at which the train does not stop, attracts a great deal of attention.

There is also a fine model of the *Connaught*, Holyhead and Kingstown mail packet.

The engines in the English department are all working well. The pair of horizontal non-condensing engines by Messrs. Galloway and Sons, of Manchester, of 100 h.p., for strength, simplicity, and compactness are not to equalled in the whole building. The cylinders are 26in. in diameter, with 3ft. stroke, contained within the bed-plate, which is a single casting; the slide valves are on the usual system and placed between the cylinders; the shaft is well balanced by two fly wheels. This engine drives the whole of Messrs. Platt's machinery for cotton and woollen spinning, Messrs. Lawson's flax spinning machinery, &c.

The Allen engine, by the Whitworth Company, attracts a great deal of attention, not only from the high speed at which it runs,—200 revolutions per minute,—but from the particularity of the valve gear. The cylinder is 12in. in diameter, with 2ft. stroke; it is also condensing; the air-pump is worked by a single-acting ram, worked direct from the piston.

The wood-cutting machinery by Worssam and Co., Powis and Co., Robinson and Co., is driven by one of Messrs. Ransomes and Son's portable engines.

Messrs. Hicks, Hargreaves and Co., of Bolton, have furnished a horizontal engine fitted with the Corliss valve gear. The diameter of the cylinder is 16in., with 36in. stroke. This engine furnishes power to Messrs. Ferrabee's wool-carding machine and to the various looms by Messrs. Hall, Hodgson, and other well known makers.

Messrs. Fox, Walker and Co., of Bristol, exhibit a 10-horse engine at work.

Messrs. Platt and Co., of Oldham, are well represented here. They exhibit a complete series of preparing, spinning, and weaving machinery. Their "Macarthy" gins are fitted with rollers made up of jute, instead of being covered with leather; the jute is put on the rollers in rings; they are found to be very durable and easily replaced when worn out. The same makers exhibit two carding machines; one with rollers, and the other with endless chain of self-stripping flats; the latter machine is best adapted for more delicate kinds of cotton.

Their drawing, roving, and spinning frames are of excellent construction. They have also a power loom at work, weaving woollen stuff.

Since 1862 perhaps more improvements have been made in rock-boring and tunnelling machines than in any other class of machinery, and the English are certainly not behind their neighbours in this respect.

Capt. Beaumont's rock-boring machine is now in working order and seems to be admirably adapted for the purpose; it was constructed by Messrs. Bryan, Donkin and Co., of London.

The engine for compressing the air is of 25 nominal horse power, and the air is stored up in a reservoir. The boring apparatus consists in a circular frame, carrying a great number of drills at the end of the piston-rod, which is worked backward and forward by the compressed air; the stroke can be regulated from ¾in. to 4in. With a 3in. stroke, 140 to 180 blows may be made per minute. A rotary motion is given to the frame, and a circular groove is cut, leaving a cylindrical core, which is blown away with powder.

The patent coal-cutting machine of Messrs. Jones and Levick may also be seen in working order, it is simple in construction and does not easily get out of order. It is also worked by compressed air, the exhaust of which helps ventilation and tends to cool the mines.

Another coal-cutting machine is exhibited by Messrs. Carrett, Marshall and Co., it is worked by hydraulic pressure.

Messrs. Bradford and Co.'s washing, wringing, and mangling machines attract a good deal of attention, and seem to be the simplest and most effective in the whole exhibition.

Messrs. Saxby and Farmer exhibit a splendid working model of their patent railway signals, illustrating their method of interlocking points and signals. Judging from its success on the English railways, we have every reason to anticipate that before long it will be adopted on most of the Continental lines.

Passing on to the American department, where the Corliss engine, with its highly-finished plated cover, is at work, we meet with several rotatory engines, the most practical of which is by Mr. Behren. The Hicks engine also is working at high speed. The Americans also exhibit their rock-boring machine by Mr. Haupt, of Philadelphia; although of the most simple construction and easily managed we should not think it well adapted for tunnelling, as steam is used as a motive power; we should confidently recommend a trial by compressed air or water.

In the park Mr. Shaw, an American, is exhibiting a 25 horse-power engine, worked by heated air, of which the consumption of fuel per indicated horse-power is stated to be exceedingly small.

The machinery in the Italian and Spanish departments, which, till quite lately, was still in packing-cases, is now in order, and forms quite a creditable exhibition for those countries. In the former the display of iron work is first-class. Westermann and Co., of Genoa, exhibit a small pair of horizontal screw engines. Ansaldo and Co., of Sampierdarena, a propeller shaft, trunk piston, and other parts of a 600 horse-power marine engine which would not disgrace any of our large firms. There are also several silk winding machines of good construction. The collection in Class 40 is most extensive, and shows the immense mineral wealth of the country. A well-built covered goods' waggon is exhibited by the Roman Railway Company, who also send a a good many specimens of excellent workmanship, such as pistons, connecting rods, axles, axle-boxes, &c.

Krupp, of Essen, in the Prussian department, has a splendid exhibition of steel guns, forgings, &c., the principal objects of which are the celebrated gun, weighing upwards of 50 tons. It is entirely of cast steel, and is a rifled breech-loader of 14in. bore. The carriage is of steel and weighs about 15 tons. This gun was brought to Paris on a railway truck specially constructed for the purpose, of iron and steel. There are also a 40 ton ingot, and a double crank shaft 24ft. in length, 15in. in diameter.

The Belgian machinery which, during the last month, was in a very unfinished state, is now in working order. Messrs. Dorzée and Andry, of Boussu, near Mons, exhibit a fine pair of 200 horse-power inverted cylinder colliery winding engines, of excellent workmanship. The cylinders are 36in. in diameter, with 4ft. 8in. stroke. An apparatus for the manufacture of sugar from beet-root is also shown by the same firm. The Société Anonyme de Châtelineau also exhibit a pair of 20 horse-power colliery winding engines. The Société John Cockerill exhibit a fine vertical blowing engine, the blowing cylinder of which is about 9ft. in diameter. The following will give some idea of the importance of this establishment, the principal works of which are at Seraing, near Liege, and cover 177¾ acres. Their shipbuilding establishments at Antwerp and St. Petersburg cover about 17¼ acres, their mines about 27½ acres; about ⅛ of this vast area is covered with buildings. The total number of persons employed last March on these works amounted to 7,227. £266,400 is yearly paid away in wages. The total horse-power employed on the works is 2,843, supplied by 156 steam engines, with an annual consumption of fuel of 220,000 tons. The value of the annual produce of these works may be estimated at about one million sterling.

The locomotives are placed in the Belgian annexe. The first on entering is a four-wheeled colliery engine by the Société Anonyme de Couillet. The next is a six-wheeled coupled inside cylinder engine by the Compagnie Belge, of which M. Evrard, of Brussels, is the director; this company also exhibit a railway carriage with first, second, and third class compartments; and a wrought iron goods' waggon.

The locomotive by the Société John Cockerill is a six-wheeled passenger engine constructed for the Belgian States Railway. The cylinders are inside, 17in. in diameter, with 22in. stroke. The two pairs of hind wheels, 6ft. 7in. in diameter, are coupled, and the leading wheels are 3ft. 11in. in diameter. The grate surface is 117 sq. ft., and the tube surface, 1000 sq. ft., forming a total heating surface of 2,117 sq. ft. The number of tubes is 208. The weight on driving wheels is 22 tons 18cwt. The weight of this engine when empty is about 30 tons, and in working order about 32½ tons.

The Société de St. Leonard, of Liege, sends a six-wheeled coupled goods engine, adapted for heavy gradients and sharp curves, with a four-wheeled bogie truck in front. The coupled wheels are 4′ 3″ in diameter. The cylinders are outside, and inclined, as they are placed high, so as to be above the bogie.

Messrs. Fétu and Deliège, of Liege, exhibit several well-made machine-tools, the most remarkable being a large facing lathe, the face plate of which is nearly 12ft. in diameter.

One of the most curious establishments to be seen at the Paris Exhibition are the diamond-cutting works in the Dutch section in the Park. The building may be remarked for the simplicity and solidity of its construction. It is well known that the Dutch excel in the art of polishing and cutting this precious stone, and at the works in the Champs de Mars may be seen the whole operation. The mills, driven by steam power, make 2,500 revolutions per minute.

Passing on to the French section, the process and modes of work carried on in Class 95 attract a great deal of attention, and perhaps one of the most popular sights in the whole Exhibition is the manufacture of felt hats by M. Haas.

The first operation is the *bâtissage*, or building-up, which consists in blowing out, by means of a fan, about four ounces of rabbits' fur on to a revolving cone of copper pierced with holes, from which the air is exhausted; by this means the hair is attached to the mould; when four ounces have been deposited on the mould, it is covered with a wet cloth, and steeped in a tub of hot water for a few minutes. After this it undergoes several processes of drying, heating, rolling, binding, and lining with silk, and a hat is made ready for use in about fifty minutes.

M. Farcot and Sons exhibit a 12-cwt. double-acting steam-hammer. The diameter of the steam cylinder is 16″, with a 2′ 8″ stroke. The arrangement of the valves is highly ingenious.

The same firm exhibits a horizontal condensing engine at work, of 50 H.P., and another of 20 H.P., in the Austrian section.

Interesting experiments have lately been made with Rouquairol-Denai-

rouze diving apparatus, and showed to great advantage when compared with the ordinary apparatus in use.

Trials with the steam fire-engines have likewise been made, and experiments in heating, lighting, ventilation, and water-cooking apparatus are continually being made in the English testing-house.

The Suez Canal Company's Exhibition, in a special building in the Park, will, when completed, be most interesting. It will contain a diorama of the Isthmus, showing the works of the canal from Port Said to Suez. It is now being painted from drawings, photographs, &c, by M. Rubé, under the direction of M. Alfred Chapon.

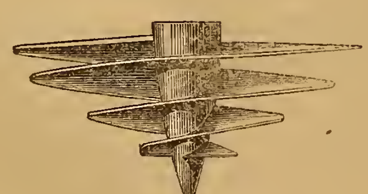
The part at present open to the public contains a collection of objects of natural history, geology, and antiquities from Egypt. A map in relief of Lower Egypt, showing the course of the Nile from Cairo to Alexandria, the Maritime Canal from the Mediterranean to the Red Sea, and the course of the fresh water canal from Cairo to Suez occupy the greater part of the building, and give a good idea of the magnitude of the undertaking.

The models of the various machines and implements which have been employed on these works are most interesting; and, lastly, there is a series of photographic drawings and paintings, showing the works of the canal in progress.

Messrs. Schneider and Co., of Creusot, have a highly interesting exhibition in a special building of their own in the park near the Porte de l'Université. These works are the largest in France, occupy an area of not less than 294 acres, of which 47¾ acres are covered with buildings; upwards of 9,950 workmen are employed by this firm, and the total horse-power in the various mines, collieries, blast furnaces, forges, and workshops amounts to 9,750. The three locomotives exhibited by Messrs. Schneider are:—an express engine for the Great Eastern Railway (England), built from designs furnished by Mr. Sinclair. The cylinders are 16in. in diameter, with 24in. stroke, with 7ft. 1in. driving wheels, and weight nearly 30 tons. It is intended to travel at a speed of 56 miles per hour, with 27 carriages. A goods engine of the same type as those used on the Creusot Railways; this engine has three pair of wheels coupled, 4ft. in diameter. A small 2ft. 7¼in. guage engine, the "Creusot," for the mineral railway of Blanzy, weighing about 6½ tons in working order. The cylinders are only 8in. in diameter, 14¼in. stroke, and the four wheels are 2ft. 6in. in diameter, and coupled. Since 1838 1,100 locomotives have been made at Creust, both for France and abroad; 168 marine engines have also been constructed by this firm for the Imperial and merchant navies. The 950 nominal horse-power marine engine constructed for the iron-clad *L'Océan*, is of the type generally adopted by the Imperial French navy, it has three horizontal cylinders, 82½in. in diameter, with 4ft. 3in. stroke. The steam is admitted into the middle cylinder at high pressure, and afterwards used expansively in the other two, on Woolf's system. The actual horse-power is 3,800. A pair of 48in. cylinders, with 2ft. 4in. stroke, horizontal marine engines of 265 nominal horse-power, forming half the engine power of the iron-clad coastguard ram, *Le Cerbère*, are also exhibited here. A quantity of specimens of iron, mineral coal, drawings of machines and bridges constructed by the firm, with plans of workshops, workmen's cottages, schools, &c., are also exhibited.

FOUNDATION SCREWS FOR LIGHTHOUSES.

Screws have of late years been extensively used by the United States Government for the support of iron lighthouses, such as we illustrated in THE ARTIZAN for August and November, 1862. Hitherto the piles were supported on sandy ground by single-threaded screws of 2ft. 6ins. diameter, which have given general satisfaction. Messrs. Poole and Co., of Wilmington, Delaware, are now constructing double-threaded screws of larger size, to be used on marshy ground in the Sixth Lighthouse District. We have been favoured with a stereoscopic view of one of these screws, from which the annexed wood engraving was taken. The dimensions are as follows:—



Largest diameter	5ft.
Smallest diameter	1ft. 4ins.
Number of threads	2, making 1½ turns each.
Pitch	12ins.
Diameter of hub	12ins.
Thickness of blade at hub	1⅜ins.
Ditto at periphery	¼in.

In plan the first third of the circumference is a true circle, the rest is an Archimedean spiral.—We may add that screws of the above size are no novelty in this country; as regards the double-thread principle it has yet to stand the test of practical experience.

IRON FLOATING DOCKS.

We have recently inspected at the yard of Messrs. Campbell, Johnstone and Co. (the patentees), at Silvertown, an enormous wrought-iron floating dock, now in course of construction, which is capable of dry-docking ships of the *Bellerophon* class, and is intended for the Government service at Bermuda, thereby being convenient for the West India and North American squadrons.

It is proposed to build the dock complete where it is, and launch it broadside on; the naval authorities being of opinion, that it is capable of being towed out to Bermuda. This is a matter of great importance, as it obviates the necessity of a large establishment at that station, which would be requisite for the purpose of putting the dock together, were it shipped in pieces from England, and avoids great delay and saves much additional expense attending the completion of a dock of such magnitude abroad. It is rather a bold experiment to tow such an enormous structure across the Atlantic, but as it is, or ought to be, unsinkable, it cannot easily be lost, even though the vessels towing it should be compelled to cast it off. They might perhaps make it self-propelling by fixing a powerful steam vessel in the dock itself,—forming thereby a nautical illustration of a snail.

The dock is 333ft. long from end main rib to end main rib, and 380ft. long over all of cutwaters. Its width is 83ft. 9in. inside, and 123ft. 9in. outside the ironwork. The depth over all of the ironwork is 71ft. 11in. The plates and bars, which are principally from the Iron Company, are of large size and weight, and appear to be of very good quality. The total weight will be about 8,000 tons, and there will be nearly three million rivets used in the manufacture of the dock.

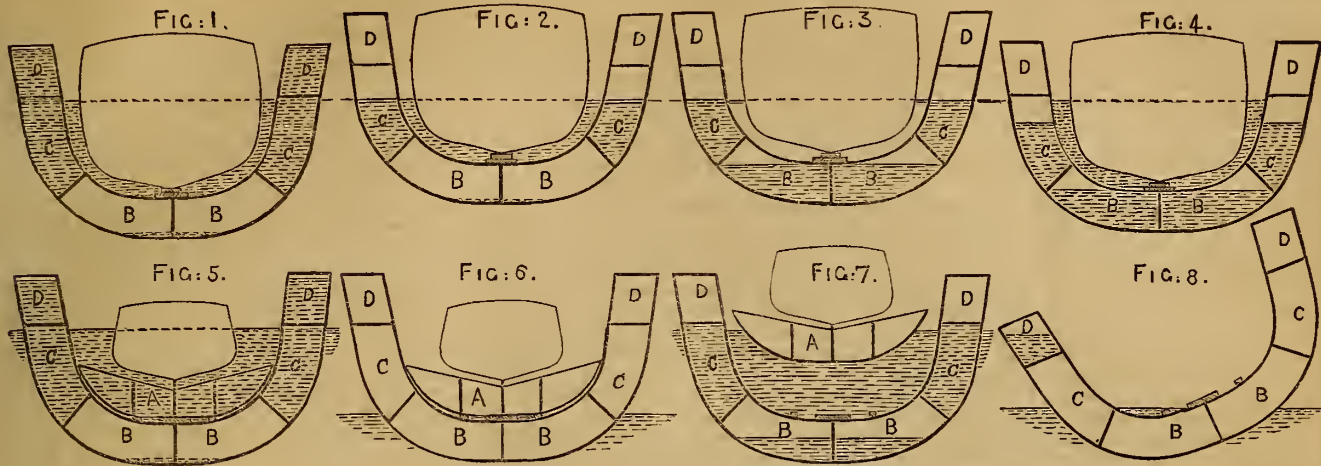
The following description in connection with the annexed woodcuts will explain the peculiar features of the structure, as well as the methods of docking and undocking, and of careening the dock.

The whole of the construction is divided into 48 watertight compartments formed by 7 watertight longitudinal bulkheads, 9 watertight transverse main-ribs, and the outside and inside skins. The compartments consist of load or upper chambers D, balance or intermediate chambers C, and of air or bottom chambers B, for the various operations of floating, loading, raising, or lowering, as required. It is intended that when the dock is out of use and ready to receive any vessel requiring repairs, the load chambers D, and the balance chambers C, should be full of water, and the bottom chambers B full of air, as in Fig. 1.

When a large ship requires repairs, it has only to be hauled into the dock, when the valves are opened, and the water is allowed to flow from the load chambers D; the ship in a short time grounds on the blocks, and the dock and ship rise out of the water, say 10ft., as shown in Fig. 2; the caissons are then put in at the ends, and the water that remains round the ship is allowed to flow into the air chambers B, leaving the vessel dry, as illustrated in Fig. 3. When the repairs are completed, the water is admitted into the dock in the usual manner, through sluices on the caissons (see Fig. 4), after which the caissons are removed, and the ship is undocked. The pumping-engines are now set to work, and the water in the chambers B is pumped into the load chambers D, and over the side; the dock is then ready for another vessel.

The contractors have suggested to the Admiralty the addition of moveable trays or pontoons, of sufficient buoyancy and stability to dock small ships upon—each of these trays or pontoons to be lifted up by the dock, emptied, and then floated out with the ship on it. By this arrangement as many small ships can be docked at one time as there are trays or pontoons. Thus, in Fig. 5, A is the pontoon or tray: the small vessel requiring repairs is floated upon this tray, when the water in the load chambers D is allowed to flow out, and also as much from the chambers C as is sufficient to raise the bottom of the pontoon above the water, as in Fig 6. When the pontoon is emptied, and the valves shut, the chambers B are filled with water, which causes the dock to sink down, leaving the pontoon floating with the vessel (Fig. 7), which can then be removed. Thus it is evident that by this arrangement, as before stated, the number of vessels capable of being docked is only limited by the number of pontoons available.

One of the principal objections hitherto raised against the use of floating docks has been that, though vessels might be repaired and cleaned on them, the dock itself could not be repaired or cleaned. As the cost of such a structure is necessarily very large, the question of durability is one of great importance, and facility for repairing and cleaning the bottom, especially in hot climates, is essential to durability. The system of dividing each side of the dock into upper, middle, and lower compartments, provides



for this contingency, as it is only necessary to fill with water one or more lines of compartments on one side, leaving the other side empty, as in Fig. 8, when the dock will careen over to any desired extent, and sufficiently so to expose the line of keel.

We think it will be acknowledged by all practical men that the peculiar features above described, viz., the absence of pumping during the processes of docking and undocking ships, the employment of pontoons for small vessels, and the facilities for cleaning and repairing the dock itself, are undoubted improvements; and great praise is due to the Admiralty for having adopted this design as the most suitable for the station of Bermuda.

H.M. TRANSPORT "EARL DE GREY AND RIPON,"

Built by the Thames Iron Works Company, Limited.

(*Illustrated by Plate* 316).

In our last number we gave a full description of the double piston-rod surface-condensing engines of the *Earl de Grey and Ripon*, and we now give, on Plate 316, some sectional views showing the engines and boiler as fitted in the vessel. Fig. 1 is a longitudinal section of the ship; Fig. 2, one-half of a transverse section through boiler, and one-half front elevation of the same; and Fig. 3, a cross section showing the general arrangement of the engine room. We need not now add anything to the particulars of the construction given in our last number, but the following abstract of the log of each of the first eight trips of the *Earl de Grey and Ripon* may enable the reader to form an idea of the performance of the ship, and the working of the engines.

Voyages to and from Portsmouth and Woolwich, of H.M. W.D. Steam Transport "Earl de Grey and Ripon."

Date, 1867.	Average Steam Pressure in lbs.	Average Vacuum. in lbs.	Average Revolutions per minute.	Water in Boiler. Density.	Height above tubes.	Knots run per Voyage.	Cargo per Voyage, in Tons.	Number of hours under Steam. H. M.	Number of hours Steaming. H. M.	Coals consumed per voyage. TONS. CWS.
Jan. 28 to Feb. 1......	19	13½	78	$\frac{1}{32}$	10	212	400	28 50	22 45	12 18
Feb. 13 to Feb. 15 ...	19	13½	77	$\frac{1\frac{1}{4}}{32}$	10	191	390	25 45	21 20	12 3
Feb. 28 to March 1...	19	13½	78	$\frac{1}{32}$	10	193	300	22 30	19 0	8 11
March 8 to March 9	19	13½	78	$\frac{1}{32}$	10	196	350	24 45	22 30	9 10
March 19 to March 21	19	13	78	$\frac{1}{32}$	10	194	330½	23 35	20 40	9 10
April 2 to April 4 ...	17	13	70	$\frac{1\frac{1}{4}}{32}$	10	194	395	27 45	23 45	12 3
April 16 to April 18	18	14	72	$\frac{1\frac{3}{4}}{34}$	10	202	320	30 0	25 30	12 4
April 26 to April 27	18	13½	76	$\frac{1}{32}$	10	197	338	25 30	22 30	10 19

Cargo consists of Government stores, heavy ordnance, munitions of war, shells, machinery, &c.

THE METROPOLITAN DISTRICT RAILWAY.

The present Metropolitan Railway, from Bishop's-road, Paddington, to Moorgate-street, is but the northern side of an irregular circle of underground railways designed to surround that part of London which is between the Thames and that line. Of this inner circle, as it is called, the Metropolitan District Railway will be the southern portion, while the eastern and western portions will be formed by extensions of the Metropolitan Railway. The Acts for the construction of these new lines were obtained in 1864, Mr. J. Fowler and Marr Johnson being the engineers.

The eastern extension of the Metropolitan Railway is carried under Bishopsgate-street, near Houndsditch, and then curves to the south, extending, under Aldgate High-street and the Minories, to Trinity-square. At Trinity-square the Metropolitan District Railway commences, and from thence proceeds nearly parallel to the river until it crosses the line of the new street which is to be constructed from Blackfriars-bridge to the Mansion House. Following along this street, the Railway meets the river at Blackfriars, and will then be carried along the Embankment to near Westminster-bridge. Here the line, leaving the Thames, curves to the west, and proceeds past Westminster Abbey by Victoria-street to the Victoria Station. It then passes near Ebury-street to Sloane-square, and from thence to Cromwell-road. Here it joins the western extension of the Metropolitan Railway, which, at Cromwell-road, curves to the north, proceeding in a north-westerly direction to Notting-hill, from whence it curves to the east, joining the present line at Edgeware-road, Paddington.

About one-half of this railway will be level, about a quarter of a mile will be on a gradient of 1 in 300, more than half a mile will be 1 in 250,

three quarters of a mile 1 in 200, and about half a mile 1 in 100; the remainder of the gradients will be rather steeper than 1 in 100.

The sharpest curve has 10 chains radius near the Victoria Station; the others have radii of respectively 15, 20, 30 chains and upwards. A portion of the line, constructed opposite the Cannon-street Station of the South Eastern Railway, being 225ft. in length, is covered over by wrought-iron girders bent downwards at the ends. On these girders are built brick walls, between which arches are turned, and which carry the road above.

At Westminster, the portion of the line from near Westminster Bridge to opposite the Westminster Hospital is completed. The line at this point is in girder-covered way, the roofing being formed of cast-iron girders with brick arches between each of them. Under Parliament-square-gardens the side walls are constructed with 6ft. bays, measuring from centre to centre of the counterforts. The girders are 6ft. apart, and 1ft. 6in. deep in the centre. Nearer Bridge-street, however, the walls are with 8ft. bays, the girders being 2ft. 6in. deep in the centre, and this is the usual construction of girder-covered way along the line.

The girders have top flanges 7in. × $1\frac{3}{4}$in., and bottom flanges 20in. × $2\frac{1}{4}$in., the web being $1\frac{3}{4}$in. thick at the top, and 2in. at the bottom; there are cross-flanges underneath, 6in. deep, which bear against the inner side of the side walls, and thus stretch them apart; the distance between the walls is 25ft. The brick arches between the girders are 3 rings thick, the spandrils being filled in with concrete, over which is a layer of asphalte $\frac{3}{4}$in. thick, put on in two coats. Upon the asphalte there is laid under the streets 1ft. of road metalling. The clear height of the under sides of the girders above rail level is 13ft. 6in.

The counterforts of the side walls are 5ft. 6in. deep horizontally for the whole height, being built without batter; and their thickness is three bricks in front of, and two bricks behind the arched panels. The panels are formed of three rings of brickwork, and are built with a batter. The walls are founded on concrete carried 5ft. below rail level, and the panels are also backed with concrete to the level of the backs of the counterforts, each bay being provided with a 4in. pipe packed around with gravel for the purpose of drainage. An 18in. barrel drain is also carried down to the centre of the line at a variable distance below rail level, and from Blackfriars bridge to Gloucester road the excavation will be provided with a concrete invert 2ft. 6in. thick.

The construction of the covered way is carried out in the following manner:—Two trenches are excavated at the proper distance apart for the side walls, and the ground between them is, when necessary, removed to make room for the girders. The sides of the trenches are, of course, supported in the usual manner by struts and poling boards, and as the construction of the side walls proceeds, these are removed and replaced by the concrete backing at the back of the walls and struts extending from the inner sides of the walls to the central portion or "core" between the two trenches. These last-mentioned struts are allowed to remain until the brickwork has thoroughly set, and when the covered way is completed, the central core is removed by excavation at each end. By proceeding in this manner, no earth, gravel, &c., need be lifted but that which is to be taken out of the trenches for the side walls, and this is raised by the aid of steam cranes traversing on temporary rails laid by the side of the excavation. These cranes lift about $\frac{1}{2}$ cub. yd. every minute, or about 30 cub. yds. in an hour. At the Westminster portion of the line the excavations are made almost entirely through sand and gravel (the clay being however reached near a foundation level), and by carrying out the plan of end excavation of the central core, the material can be easily removed in waggons running on temporary rails to other parts of the line, there to be screened, if required, for mortar or concrete, or else sold at a good price. If the excavation were completed at once and the part forming the core removed, before the covered way was finished, great expense would be incurred on account of there being but in few cases sufficient space for the excavated material, and all that portion which could not be immediately disposed of would have to be carted away.

When the excavation has to be carried under a street, a very simple method of making a temporary bridge is in most cases adopted. The bridge is formed of half the width of the road at one time, so as to interrupt the traffic as little as possible. Longitudinal trenches, about 2ft. 6in. deep, are first cut in the roadway, 4ft. apart, these trenches being long enough for timber balks which will span the intended excavation. The road between the trenches is then lowered, and cross planking placed on the balks, and on this planking is spread about 1ft. of road metalling. After the whole of the temporary bridge is constructed in this manner, the ground underneath is excavated, and the construction of the railway is proceeded with.

When water and gas pipes are met with, which are afterwards supported by the roof of the covered way, they are slung from balks overhead, and strutted from the ground below; and as the work proceeds, the original struts are replaced by larger ones. The brick sewers which cross the line of railway are also supported in a similar manner until replaced by iron ones. Near Parliament-square Gardens the present Victoria-street sewer crosses the railway in this manner. In this case the sewer has been diverted, and a length of the former brick sewer replaced by a new sewer along the southern side of the railway at the back of the side wall, joining to the low level sewer at the Thames Embankment. Another similar sewer has been found along the northern side of the line for some distance, so as to intercept the sewers which now extend from that side to the Victoria-street sewer at the point where it leaves the northern side of the railway.

Near the end of Victoria-street the centre line of the railway passes about 95ft. from one corner of Westminster Abbey, and for a length of 300ft. near this point, a retaining wall of extra strength is built along the southern side of the line. This wall, instead of being built in bays, is made 5ft. 6in. thick throughout, and backed with peat 7ft. in thickness. This thickness, however, is reduced at the bottom, where the sewer already mentioned is situated, the sewer being formed for this length of 300ft. of iron pipe, 4ft. 6in. in diameter. This method of peat backing has been adopted at the recommendation of Mr. G. P. Bidder (acting as engineer to the Dean and Chapter of Westminster), in order to prevent the transmission of any vibration from the railway to the Abbey. We may mention here that it has been sometimes stated that the Abbey was founded on a running sand, but in these excavations good sound gravel only has been met with.

Owing to possession not yet having been obtained, nothing has as yet been done towards the construction of the line from Westminster Hospital to Buckingham-row, with the exception of some slight excavations near to the St. James's Park Station, Broadway, Westminster. This station will have siding accommodation. Between the St. James's Park Station and Buckingham-row the line will be carried partly through girder-covered way, and partly through covered way roofed with brick arches.

At Buckingham-row another long finished length of the works commences, there being first a short length of brickwork-covered way, and then about 160yds. of open cutting. The difference between the brickwork-covered way and a tunnel is chiefly that, in making the latter, the excavation is driven from the ends, whereas in constructing the brickwork-covered way, the ground is opened up to the surface and then filled in again upon the top of the arches. In the case of the Metropolitan District Railway there is no tunnel properly so called at any part.

In the ordinary brickwork-covered way the arches are composed of five rings of brickwork, and have a span of 25ft., the clear height under the crown of the arch being 15ft. 9in. above rail level. The curve of the crown the arch is struck with a radius of 15ft. 9in., and the haunches with radii of 9ft. 6in., whilst the side walls have a curved batter on the face, struck with a radius of 25ft. from a centre situated 5ft. 6in. above rail level. The side walls are three bricks thick at the springing of the arch, and the back is carried down perpendicularly to the foundations. At intervals of 50ft. there are found in the side walls arched recesses or manholes, 4ft. wide, 1ft. 6in. deep in the centre, and 7ft. high, the back of each recess being formed of an horizontal arch composed of three rings of brickwork, and having a versed sine of 9in. The haunches of the arched covering are filled in with concrete, the upper surface being sloped off towards each side, and coated with asphalte $\frac{3}{4}$in. thick, laid on in two layers. At the back of the side walls drain pipes are led down to near the footings, and are then carried through the walls, the same as in the case of the girder-covered way.

The side walls of the brickwork-covered way are put in in the same manner as those for the girder-covered way already described, their curved inner faces being built to properly supported wooden templates, having each course marked on them, and each furnished with a plumb line for setting it upright. These templates extend higher than the side wall proper, and the upper part of each of them is recessed to receive lagging boards, upon which that part of the arched covering near the springing can be built. To allow of the remainder of the arch being built, the core left between the side walls is rounded off at the top, and is spanned by centreing formed of light plate-iron ribs, carrying the usual lagging boards. The ends of the ribs are supported by timbers extending from the footings of the side walls, and furnished with the usual striking wedges; and each rib is jointed at the centre, and is supported at that point by means of foot-boards and wedges resting upon the top of the central core. This plan enables the greater part of the core to be left in its place until the completion of the covering, as in the case of the girder-covered way, so that it can be removed afterwards by end excavation.

We have said that the short length of brickwork-covered way near Buckingham-row, is followed by about 160yds. of open cutting, the railway being for the distance carried between retaining walls. The walls are constructed in bays, each bay being formed of an arched panel abutting against counterforts, as in the case of the side walls of the girder-covered way. At the back of the walls the counterforts are $2\frac{1}{2}$ bricks thick, whilst in front of the panels their thickness is increased to 4 bricks. The depth of the counterforts, measured from the face to the back, varies

according to the depth of the excavation, and the rule which has been followed is, to make the depth of the counterfort at the rail level = ⅓ the height of the retaining wall + 18in. Above the retaining wall there is a parapet wall. The backs of the counterforts are carried up perpendicularly, and their front faces have an uniform batter of 1 in 8, so that the rule above given determines their depth from back to front at the top as well as at rail level.

The counterforts are 11ft. apart from centre to centre, and the arched panels between them are one brick thick for a depth of 10ft. from the top of the retaining wall, and 1½ brick thick below that depth. The versed sine of the horizontally-arched panels is 1ft., and at their springing they are set back 1ft. 6in. from the faces of the counterforts. The spaces between the panels are filled in with lime concrete level with the backs of the counterforts, the same arrangements being made for drainage as in the case of the side walls of the girder-covered way. The distance between the faces of the counterforts of the opposite walls, at rail level, is 25ft., the distance between the walls at the top, of course, varying according to the depth of the excavations. The footings of the walls rest upon cement concrete carried down about 5ft. below the rail level, as in the case of the side walls of the covered way. The parapet walls are 6ft. high above the ground level, and are panelled, the panels being one brick, and other parts of the wall, except at the string course and capping, are 1½ bricks thick.

The retaining walls, like the side walls of the covered way, are constructed in trenches of sufficient width, the ground between these trenches being left for removal by end excavation. These retaining walls, and, indeed, all the details of the works, are well proportioned to the duty they have to perform, and by their construction very great resisting power is obtained with a comparatively small expenditure of material. The excellence of the design also well accords with the quality of the workmanship, the whole of the brickwork which has so far been carried out in connection with the works of the Metropolitan District Railway having been executed in a manner which reflects the greatest credit on the contractors.

The 160yds. of open cutting which we last described, are succeeded by about 100ft. of the ordinary brickwork-covered way, this extending to the western side of the new street running from the northern side of Victoria-street. At this point the line passes under the site of a new brewery, which is to be erected by Messrs. Elliot, Watney, and Co., and as the weight to be carried above the line will be very great, a special system of construction has been adopted for the covering.

In the first place, the side walls are increased to 5 bricks in thickness, and are backed with 12in. of concrete, and for a length of 9ft. in the centre, and at each end of that portion of the line beneath the intended brewery, the arched brick covering has been made 9 instead of 5 rings in thickness, these thickened portions being so situated as to come under the front, centre, and back walls of the building. Between the 9 ring arches the railway is spanned by 12 massive wrought-iron box girders, each calculated to carry a load of 200 tons, and upon these will bear the columns supporting the immense vats with which the brewery will be furnished. Between the girders the line is roofed by the ordinary transverse brick arched covering, which is, as usual, 5 rings thick; and the girders themselves will also be covered over by longitudinal arches, having apertures in them through which the columns already mentioned can pass.

At the point that we have been describing, the foundations of the side walls of the railway are situated 15ft. below those of some very high houses close to which the line passes, and the works had, therefore, to be executed with the greatest possible care. The precautions taken, however, were so effectual that not the slightest damage was done to the adjoining structures. Past the site of the brewery the ordinary brickwork-covered way recommences. Before reaching the line of Victoria-street, the railway passes for some distance under the space upon which the houses which will eventually form the northern side of the street at this point will be built, and here the covered way has been constructed of more than the usual strength, in order to carry the extra loads which will come upon it.

As the railway approaches Victoria-street at an acute angle, the side walls of the houses will cross the line on the skew, and the strengthening of the arched covering has accordingly been carried out as follows: The houses to be built will each have a frontage of 25ft. 6in., and the centre lines of the side walls have been set out at that distance apart. For a distance of 7ft. 6in. on each side of each of the points at which these lines intersect the centreline of the railway, the brick arched covering has been constructed 10 rings in thickness, whilst between the portions so thickened the thickness has been made 8 rings. This part of the brickwork-covered way will thus consist of alternate 15ft. and 12ft. lengths, 10 rings and 8 rings thick respectively, and the side walls of the houses will bear upon the 10 ring lengths exclusively. At each end of each of the 15ft. lengths there is also formed a counterfort 2ft. thick; these counterforts extend to the outside line of the side walls, and their tops are made to the same slope as the spandril filling.

Close to the junction of Vauxhall-road and Victoria-street, the Metropolitan District Railway crosses under the latter street, and also under the King's Scholars' Pond Sewer, and this point is the lowest on the line of the railway, the rail level being here 21ft. 9in. below Trinity high-water, or 9ft. 3in. below Ordnance datum.

The sewage is conducted over the railway through a cast-iron tube about 13ft. wide and 11ft. high, this tube having an arched invert, and sides and crown of a horse-shoe shape. The tube crosses the railway on the skew and is supported by a pair of cast-iron girders, placed one on each side of it, the distance apart of the girders from centre to centre being 15ft. 6in. The height from rail level to the invert of the sewer is only 13ft. 7in., and thus the latter had to be made so as to lessen the headway as little as possible. This has been done by forming the invert of plates stiffened by ribs on the inside, these ribs being placed longitudinally, so that they do not interfere with the flow of the sewage. The widest plates are also supported by transverse girders extending under them from one main girder to the other, and disposed parallel with the line of the railway, so that they will permit the engine chimneys and highest portions of the carriages to pass between them. The cast-iron tube is protected above by a brick relieving arch of 18ft. span, which comes between it and the roadway. As the circumstances of the case did not permit the King's Scholars' Pond Sewer to be diverted during the construction of the iron tube, the sewage had to be conducted through a temporary wooden trough, 6ft. deep and 6ft. wide, and around this the tube was built. The whole work has been carried out with perfect success.

The Victoria-street Station of the Metropolitan District Railway will adjoin the existing station of the same name; and its construction is proceeding rapidly. It will be 336ft. 6in. long, by 50ft. 5½in. wide, and the platforms, having each 15ft. in width, will be furnished with separate staircases for the ordinary metropolitan traffic, and the exchange traffic with the London, Chatham, and Dover and London, Brighton and South Coast Railways. The station buildings will have three floors; one at the platform level, a mezzanine floor upon which the booking offices will be situated, and an upper floor above the street level. The walls are faced on the inside with Suffolk bricks, and are very fine specimens of brickwork. They are panelled, and a very good effect has been obtained, both in this and the other stations on the Metropolitan District line, by making the arches over the panels project 1in. beyond the regular face of the wall. The roof of this station consists of a series of wrought-iron arched ribs. The thrust of these will be received by castings built into the side walls, and secured by bolts passing through to washer plates at the back. At the Victoria Station the foundations of the walls are 29ft., and the level of the rails is 24ft. below the surface of the ground, and on one side of the station a well has been sunk 15ft. below the rail level. The 18in. culverts, which we have mentioned as being formed down the centre of the line, communicate with this well, and all that portion of the line which slopes downwards to the Victoria Station will consequently be drained into it. The water will be raised from the well by a small pumping engine provided for the purpose, and similar pumping stations will also be formed at Sloane-square and Cromwell-road.

From Victoria Station the line continues in ordinary covered way. At Ebury-street the rail level is 28ft. below the surface, and the works commence with 100ft. of the ordinary brickwork-covered way. This is succeeded by a length of open cutting extending to within about 50ft. of Graham-street, and as there was not room to construct the retaining walls of sufficient thickness, their tops will be strutted apart by cast-iron struts extending across the line. From Graham-street to Sloane-square the line is in ordinary brickwork-covered way, and this has been already constructed, and is ready for the excavation of the core. The sewer which traverses Graham-street is carried over the line in a pipe 4ft. in diameter; this pipe, which crosses on the skew, being supported partly by the brick-arched covering, and partly by five girders provided for the purpose.

At Sloane-square a station 312ft. long, by 50ft. 5½in. wide, between side walls, is in course of construction. The platforms will be each 15ft. wide, and the general details of the building, roof, &c., will be the same as those of the Victoria-street station, of which we have already spoken. At the Sloane-square Station the Ranelagh sewer—a sewer with a 9ft. barrel—crosses the line of the railway on the skew, and will be conducted over it through a wrought-iron tube of 67ft. span.

From the Sloane-square Station to the New Brompton-road the line passes through brickwork-covered way, except for a few lengths of open, not amounting altogether to more than 300ft. Near the end of Onslow-terrace, the covered way just mentioned will terminate, the end being made with a bell-mouth opening on the Cromwall-road Station-yard, which will be between retaining walls. At the works near the New Brompton-road, a greater quantity of water is met with than at any other part of the line. The level of the rails will here be 24ft., and the foundations of the wall 29ft. below the surface, whilst the water is met with at a depth of 9ft. The pumps employed are all Murray's patent chain pumps, driven by ordinary portable engines. From the Cromwell-road Station to that at Gloucester-road, the four lines of rail will pass through a double-covered

way, consisting of two lines of the ordinary brickwork-covered way placed side by side, with a 4ft. 9in. pier between them.

The Gloucester-road Station is in a forward state. It will be 308ft. long by 84ft. wide, this width giving space for one 16ft, and two 14ft. platforms, besides the four lines of rails. The booking-office will be at the end of the station, and access to the platform will be obtained by staircases leading from a transverse gallery.

At Kensington Station the northern of the two branches of the Metropolitan District Railway which connect the "inner circle" with the West London Railway terminates, whilst the Metropolitan extension line passes through the station yard and continues its course to Paddington. The main portion of the station is 418ft. long, by 90ft. 2¾in. in width between the walls, and it is furnished with three platforms and four lines of rails. Commencing at the north-eastern side of the station, there is, first, a platform 14ft. wide, then a space of 20ft. 5½in., through which the two lines of rails of the Metropolitan Extension Railway pass; then a 19ft. platform, then a space of 9ft. 6½in., accommodating one of the lines of rails of the Metropolitan District Railway; then a platform 16ft. wide, and, finally, a space of 11ft. 2¾in., in which the other line of the Metropolitan District Railway is situated. The total length of the station is 468ft., the space of 50ft. next the High-street being occupied by the booking offices, &c. The arrangement of the booking offices, &c., will be very similar to that adopted at the existing Metropolitan Station at Aldersgate-street.

INSTITUTION OF CIVIL ENGINEERS.

ON OPTICAL APPARATUS USED IN LIGHTHOUSES.

By Mr. James T. Chance, M.A.

It was premised that the object of this kind of apparatus was to condense, within a small equatorial angle, the available part of the rays which diverged in all directions from a given source of light, so that the main portion of the luminous sphere might become serviceable to the mariner. The remarks were chiefly applicable to the oil-lamp, as the source of light; although, from the success which, since 1862, had attended the exhibition of the electric spark at Dungeness by means of the magneto-electric machine of Mr. Holmes, it might be fairly anticipated, that for all suitable stations of the first importance this brilliant source of illumination would ultimately be adopted.

The dioptric system of Augustin Fresnel was stated to be that which was now being generally introduced. It was described to consist of a structure of zones, or segments of glass, enveloping a central flame, whose focal rays were parallelised in a horizontal direction. In what was termed a fixed light, this deflection took place only in meridian planes, the natural divergence in azimuth being left unaltered; whereas in a revolving light, the focal rays were gathered into a number of cylindrical beams which, by the rotation of the whole apparatus, were made to pass in succession before the eye of the observer. It was further explained that, in consequence of the size of the flame, the beam which emerged from every part of the apparatus had a conical divergence; and that, although a certain extent of divergence was indispensable, both in azimuth and in altitude, for revolving lights, and in altitude for fixed ones, yet any excess of dispersion beyond this requirement involved waste of light. Hence it was necessary to increase the radius of the apparatus proportionably to that of the flame. In a first order light, for instance, with a burner consisting of four concentric wicks, the radius of the instrument in the focal horizontal plane was upwards of 3ft.; and below this there came a gradation of sea-lights and harbour-lights, in which were employed lamps whose burners had three and two wicks, and one wick respectively.

Attention was specially directed to the imperative necessity of the greatest accuracy, both in the shape of each of the generating sections of the zones and in their respective adjustments. The recent Royal Commission had rendered very great service in bringing before the notice of the lighthouse authorities of this country the essential importance of the due adjustments of the glass segments; but the author explained how exactness of adjustment would be only partially efficacious, unless accuracy of section also accompanied it; so that all points of each section should co-operate in transmitting a parellelised beam in the required direction. It was a fallacy to imagine that, because the flame had considerable size, accuracy of shape might be dispensed with. It was stated that the most effective part of the flame was comprised within a small compass; and further, that whatever portion of the light was directed towards the sea-horizon, virtually illuminated the chief range of sea-surface from the horizon towards land, in consequence of the minuteness of the angle which the main portion of the whole distance subtended at the apparatus.

The dioptric instrument was shown to consist of three main divisions:—An equatorial belt of the sphere of light, proceeding from the flame, to the extent of about 57°, was acted upon by refraction; but the rays which passed above and below this angle were deflected by total reflection. The portion of the luminous sphere thus acted upon amounted to 81 per cent., the upper reflectors receiving 22½ parts, the refracting-belt 45, and the lower reflector 13½; but from causes which were explained, the relative illuminating values, in the horizontal plan, of these three respective divisions of the apparatus were in the following proportion, viz.:—Upper reflectors, 20; the refracting portion, 70; the lower reflectors, 10. The author added, that too much stress could not be laid upon the importance of selecting for the sea-horizon, and sending towards it, the brightest sections of the flame.

One main difficulty with lighthouse engineers consisted in devising suitable characteristic distinctions among sea-lights, subsidiary to the two chief ones, fixed and revolving. They were obliged to resort to colour occasionally, but red was generally the only one admissible, in consequence of the want of power in all others to penetrate the atmosphere.

Reference was made to the circumstances under which Augustin Fresnel successfully carried out his annular lens. A commission on lighthouses had been appointed in France as early as 1811; and at the request of Arago, who, in 1813, had joined the board, Fresnel and Mathieu, a member of the Institute, were in 1819 associated with him in conducting the necessary experiments and investigations. In selecting the annular form of lens, Fresnel seemed to be quite unaware of Buffon's proposal, in 1748, to form a lens *à échelons* out of a solid piece of glass for a burning instrument, and of Condorcet's subsequent suggestion to construct the burning lens of separate rings round a central disc. Fresnel was, undoubtedly, the first to give to each ring its individual due generating section, for the purpose of correcting spherical aberration, and to apply the compound lens successfully to lighthouse illumination. This was accomplished about 1822, and a dioptric instrument of the first order with this new lens was erected at Cordonan Lighthouse, at the mouth of the Gironde. Fresnel, subsequently, introduced a cylindrical refracting belt for fixed lights, which he formed by causing the vertical generating section of his annular lens to revolve round a vertical axis through the focus; but it was applied by him only to small harbour lights: the refracting belt of all fixed sea-lights being made in a polygonal shape.

The late Mr. Alan Stevenson, who had charge of introducing the Fresnel system into Scotland, was the first to carry out the cylindrical refractor for sea-lights, and he also introduced the oblique joints.

It occurred to Fresnel to employ totally-reflecting zones for the rays which passed above and below the refracting portion of the dioptric instrument, and he actually used them in a fixed harbour light, in which, of course, the rings were generated round a vertical axis; but it was mentioned that, in a certain small apparatus at Paris, Fresnel employed reflecting zones, formed round a horizontal axis, so as to have a lenticular action.

It was stated that the late Mr. Alan Stevenson was the first to extend the application of the fixed reflecting prisms to sea-lights; and Mr. Thomas Stevenson, in 1849, proposed the employment of lenticular reflecting zones, which was carried into effect in 1851 by the Commissioners of the Northern Lights in the First Order Revolving Light at North Ronaldshay.

A description was then given of the system of adjustment and testing by internal observation, for which the Lighthouse Boards were mainly indebted to the late Royal Commission and to the Astronomer Royal, and which the Author had the opportunity of putting into practice in the readjustment of certain existing lights; a circumstance which at once led to its adoption by him in the construction of all new apparatus.

The relative merits of catoptric and dioptric apparatus were considered, and the great waste of light in the former system was pointed out; it was stated, however, that about one-half of the sea-lights of this kingdom still consisted of parabolic metallic reflectors. To construct apparatus of metallic reflectors which could at all rival dioptric lights of the larger kind was shown to be impracticable.

A description was given of the totally-reflecting spherical mirror, designed, about 1850, by Mr. Thomas Stevenson, of which a specimen, constructed by Mr. Chance, and somewhat modified by him, was shown in the International Exhibition of 1862. This system had been subsequently carried out by Mr. Chance in an improved form, and applied in several sea-lights, both fixed and revolving. The azimuthal condensing system of Mr. Thomas Stevenson was also explained, and its value was illustrated by several instances in which it had been used; amongst other places at Isle Orousay and Buddonness, by Mr. Stevenson; and by the author in the two first order lights at Great Orme's Head and Gibraltar.

The Buddonness apparatus at the entrance of the Firth of Tay was specially alluded to, as possessing certain interesting novel contrivances, and as combining in itself every existing dioptric method of lighthouse illumination; and it was explained how not only the front luminous hemisphere, but likewise about three-fourths of the back one, were made to co-operate in lighting a given sector of sea-surface, glass being the only optical agent employed throughout the apparatus.

The mathematical part of the subject was treated as an appendix, as being scarcely suitable for reading at a meeting.

At the monthly ballot, which took place on May 7th, the following candidates were balloted for and duly elected:—As members: Mr. Harry Footner, London and North Western Railway, Liverpool; and Mr. William Auboue Potter, Monk Bretton, Barnsley. As associates: Mr. Henry Slingsby Bethell, King William-street, E.C.; Mr. Armand Bonquié, St. Petersburgh; Mr. George Brown Murdoch, Walbrook, E.C.; Mr. Joseph Smith, Bradford; Mr. Henry Waugh, Great Northern Railway, Gainsborough; and Mr. Sidney William Yockney, Westminster.

LONDON ASSOCIATION OF FOREMAN ENGINEERS.

The ordinary monthly meeting of this society took place on Saturday, May 4th at the London Coffee-house, Ludgate-hill. Mr. Joseph Newton, President, filled the chair, and the spacious and well-appointed assembly room, henceforth to be devoted to the business of the association, was quite full. When the routine duties of the sitting had been performed, the chairman proceeded to deliver a lengthy and interesting address. He alluded, in the first instance, to the steadily progressive influence of the institution, and congratulated his fellow members on the fact that they had now secured for themselves a local habitation in all ways suitable for their purposes. As in the past the society had been

completely successful in realising its objects, so it would in the future if the proper amount of energy and interest was exhibited by each member. It was not for them to rest and be thankful, but to rest and then go forward with increased vigour. They now numbered 150 members, but he (the chairman) saw no reason for supposing that that number would not soon be doubled. They had it was true, among them representatives of nearly every large engineering establishment in or near London. These were mainly foremen, but their ranks were open to mechanical draughtsmen also, and he hoped eventually to see a large accession of members from that eminently useful and intelligent body. The chairman adverted to the fact that the honorary members of the society were almost all gentlemen of great eminence, and there was among them a very large proportion of employers. It was to be hoped that these and other scientific friends would be induced to attend their future meetings and share in their proceedings. Other points were touched upon and urged with considerable emphasis, and all had a bearing upon the future prospects and welfare of the association. Finally, Mr. Newton declared the new meeting place open for the despatch of business. The first question introduced and discussed had reference to a collective scheme of Life Assurance, which the chairman had suggested, and which had been favourably entertained by the great mass of the members. Mr. Fothergill, on behalf of the Royal Insurance Company, attended, and lucidly explained the arrangements which that office was ready to make for insuring the payment of £100 on the death of any and every associated foreman. The terms appeared to be advantageous for the society; but eventually a committee was appointed to inquire into and report upon the whole subject. Mr. J. Irvine next read a very elaborate and exhaustive paper on "Indicating the Power of Steam Engines." He treated the subject in a practical manner, and illustrated it by many diagrams. It is difficult to summarise the paper, which occupied nearly an hour in reading; but we strongly recommend that it be printed *in extenso* in the "Transactions" of the Society. The discussion, shared in by Messrs. Naylor, Keyte, Lishwick, Aland, the chairman, and others, was brief; and a further consideration of the subject was adjourned till the June meeting.

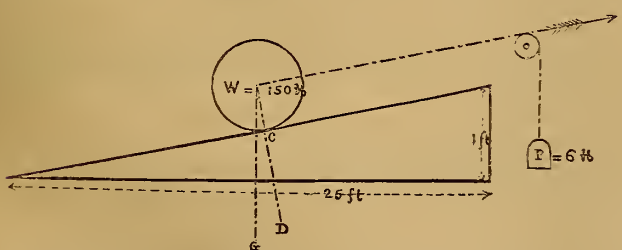
AERONAUTICAL SOCIETY OF GREAT BRITAIN.

ON THE CONSTRUCTION OF AN AERIAL MACHINE.

By H. C. Hurry, C.E., of Hereford.

The impelling of an inclosed plane in the direction of its surface, with a load suspended from it, is the most feasible mode of accomplishing aerial navigation. The supporting plane is to be made undulating transversely for the purpose of resting more steadily upon the air; this plane is to be propelled in the straight line of its surface by arms, sails (as of a windmill), screw propellers, or it may be that some other propelling apparatus will be found more applicable. The power proposed is electro-magnetism. The load is suspended from the supporting plane in a car, as from a balloon; and this arrangement is of the greatest importance for three reasons. First, it affords a most simple mode of perfect steerage, without having any working parts susceptible of injury by sudden or violent gusts of wind; this is effected by an arrangement in the car for shortening and lengthening the suspending cords at pleasure. Secondly, the centre of gravity of the load is considerably below the plane, and the danger of its being blown over is thus removed. Thirdly, in starting, the propelling screw and the supporting plane are allowed to get into full action before being called upon to support the load, so removing the difficulty arising from the slip of the screw becoming so preponderant as to carry round a disk of air through being held back at starting.

In ordinary mechanics all calculations are based upon, or rather start from, either statical equilibrium or the fulcrum (otherwise the centre of motion) of dynamics; but in aerostatics I think it may be demonstrated that the converse of these conditions takes place, or in other words, that horizontal progress is not the direct result of a power acting from a centre of motion or fulcrum, but depends wholly upon the yielding or receding of the fulcrum; and if this proves to be so, much difficulty will be removed in the consideration of the power required for sustaining and moving a body through the air. Now let it be



assumed that the incline represented in this diagram is unyielding, and has an inclination of 1 in 25, that is, 1ft. rise in horizontal length, and that the weight or load W = 150, then it follows that a power of 6lbs., acting in the direction of the arrow (or the weight P acting over a pulley) would hold W in equilibrium; but if we change this unyielding incline for the yielding plane of the atmosphere, shall we not then obtain motion? and that in the direction C D, being the resultant of the two forces W (or the weight) in the direction G, and P, or the power, in the direction of the arrow? Without giving a value to the resistance of the surface of the plane, the weight would fall 15·084ft. in one second, but if we take $\frac{1}{10}$ of a second as the unit of our time, then the initial of descent would be 0·16084ft., or at the rate of 96·5ft. per minute.

If, however, we allow for the resistance of the plane, in accordance with Mr. Wenham's statement "that 150lbs. suspended from a plane of the same number of feet area will fall 1,300ft. in a minute," we shall obtain an initial of descent of 0·00361 for the first $\frac{1}{10}$ of a second, or at the rate of 2·66ft. per minute. Therefore, if we provide a force capable of lifting a weight that height in the same time, which on the same incline would be under 9lbs., we shall exercise a counteracting equivalent to the tendency to fall, so that the body must remain at the same altitude, but will have progressed horizontally at the rate of 66·5ft. per minute. The force required I have exaggerated as taking even the $\frac{1}{10}$ of a second as the unit of time admits of accumulation of force, whereas it must be borne in mind that we are treating of a body that is ever *about to fall*, but being prevented, can never acquire an augmentation of its normal force of gravity.

The effect upon an incline of another angle must now be seen—say 1 in 100 now, upon such an incline, $1\frac{1}{2}$lbs would keep the weight 150lbs. in equilibrium, leaving the excess of $7\frac{1}{2}$ for the increased friction of machinery driven at the greater velocity, inertia, &c., but in this case, the horizontal progress would be 266ft. per minute; and the same may be shown for any other incline, and the incline for high speeds must be very slight indeed; for 60 miles per hour, it would be about 1 in 3,000.

It will no doubt be observed that nothing is allowed for the resistance and friction of the air upon the plane. True, there is not; and this is correct, for the friction and resistance are the very elements of support; they determine the angle of the plane for any speed, which would be found to be somewhat less than theory would dictate, but they do not otherwise affect horizontal progress. Does not this proposition, if true, dwarf that horrid bugbear, resistance multiplied by the square of velocity, and hold out a prospect of success, where so much has been written to engender despair?

With respect to the mode of applying the power, it would most probably be found, that a modification of the windmill arm-sail will be the best; of course that is upon the same principle as the screw propeller, but by having the sails further from the axis, a less rapid rotary motion will be necessary to obtain sufficient load for high speed, and when used as I propose, viz., for driving the plane along and not for directly supporting the load, I do not think the objection of slip would materially pertain. My reason for proposing the use of electro-magnetism as the motor, is that I believe no other means will afford so good a combination of power, rapidity of action and lightness. For me it has another attraction, that is the facilities for having the batteries in the car, they being the heaviest parts of the driving machinery, and acquiring most attention, whilst the work is done by the magnet upon the place.

INSTITUTION OF NAVAL ARCHITECTS.

RECENT IMPROVEMENTS IN THE CALCULATION OF THE STATICAL STABILITY OF SHIPS.

By Charles W. Merrifield, F.R.S., Honorary Secretary and Associate I.N.A.

The calculations of a ship are never considered complete unless her stability has been ascertained. The well-known rule of the metacentre has not been thought sufficient, because it makes no allowance for the change of form which the immersed portion of the ship undergoes in heeling, or even for the change of form of the water-line. It is therefore only accepted as a first approximation, and it is only in ships which closely approach to well-known forms that any security can be felt that their stability will not decrease as they come over, instead of increasing as the sine of the inclination.

The usual plan has been to ascertain the righting moment by calculating the moments and masses of the "ins and outs," or immersed and emersed wedges. But this involves an excessive amount of arithmetical work, and even Mr. Barnes's improved method has not brought it within the practical limits of time at the disposal of the ordinary draughtsman. Moreover, it only gives the moment for one particular inclination, and there is nothing in the calculation to suggest an approximate value for intermediate or outside angles. The result of the calculation is therefore inadequate to the labour spent upon it, even when there is time to do it at all.

It occurred to me that we might, instead of going through this process, start from the metacentre as a first approximation, and then introduce the correction due to a definite inclination, by some method which should be sufficiently exact for the object, and which should evade the calculation of the wedges. I found such an one, and communicated it to the Royal Society last February. I am happy to say that Professor Rankine has since devised an improvement, which makes it a thoroughly practical method. It has been tried in the School of Naval Architecture, and it has been found satisfactory in respect both of accuracy and simplicity. I shall not trouble the Institution by reading formulæ: these, and the arithmetical example, I shall reserve for an appendix, and meanwhile I will try to give a sketch of the method.

I must first remark that the stability of a body floating in water may be reduced to that of a body, with a curved base, resting on a table, like a Chinese tumbler, in fact. The determination of the stability of a ship really resolves itself into the determination of the representative curve which is to rest on the table. The metacentric theory supposes this curve to be a circle, or cylinder, of which the centre is called the metacentre. If you know where the centre of gravity of a cylinder is, it is an easy geometrical problem to find out all about its stability.

But it is not necessary that this representative should be a circle at all. We have reason for knowing that it cannot have any corners or gaps, and a circle

is a very good approximation for extremely small angles. But it may take a sharper cnrl as you move away from the middle point, and then its stability would not be the same as that of a loaded cylinder. That is exactly what we want to test.

Let us observe what the metacentre circle does for us when we try to draw our representative curve with the help of a batten. We get a starting point and a starting direction, and we know how much the batten has got to be bent at the starting point. This is some help. If now we get the same things farther on, within moderate limits, we might say the curve was pretty well determined —that is to say, that if (say at a difference of inclination of 10°) we could get a fresh point, a fresh direction, and a fresh curvature, we should find it very difficult to draw more than one fair curve between them. I mean that, if you drew two, yon would want a microscope to distinguish them. Now this is what can be done by a complete use of the calculations of the "ins and outs." But I never heard of its being pushed to this extent. Indeed, it would reqnire a great deal of abstruse calculation to do it; and for this reasou I consider the process wanting in economy of labour. It seemed to me that enough would be done if, iustead of determiniug, in addition to the commou metacentre, a point, a direction, and a curvature, I determined oue of the three conditions, instead of all three. And since the whole of the measurements and calculations about ships are only approximate, I did not feel at all sure that we were not putting too fine a point npon it by going beyond one such conditiou. Actual trial has shown that I am right in this surmise, at least in so far as concerns ordinary ships; for the stabilities got out (1) by my method as it first appeared, (2) with Mr. Rankine's improvement, and (3), by Mr. Barnes' method of taking the "ins and outs," differed by a very small fraction, well within the probable limits of accuracy of either method. The new method gives the result in a handier form, and with less than half the work of the old method.

Geometrical simplicity, mechanical simplicity, and simplicity of calculation, are three things which are closely allied, but do not go very far together. My method followed the first, and only approximated to the two others. Professor Rankine hit both of these, and approximated to the first. I need hardly tell you which answers the best. I shall ask you to follow me in a little mechanical explanation which will, as I think, set these methods in a very clear light.

All questions of the statical stability of ships may be resolved into the case of a pendulum. If the peudulum be suspended from a point, that is metacentric stability, and the rightiug couple varies with the sine of the inclination, or disturbance from the vertical. But if the pendulum string, instead of being fixed to a pivot, winds off a cheek, the curvature of the cheek may be so managed as to make the bob describe auy given curve, and thus represent auy given ship. I said to myself, let the bob describe the next simplest curve to the circle, namely, an ellipse or other conic section; aud let the calculations of the ship determine what conic section, exactly, it shall be.

But Professor Raukine said:—"You don't want the curve described by the bob; your mechanical conditions are settled by the cheek the string winds off (the evolute). Let that be the simplest you can get to fulfil your conditions, and let the bob take care of itself, and so you will get a simpler arithmetic;" and he thus introduced a marked improvement. His idea was to make the cheek, or, rather, the pair of cheeks, the cusp of the involute of the circle. If you want to describe this curve, take a reel of cotton and tie the end to a pencil; as the cotton winds off your pencil will trace the involute. Now, this cheek, in my method, was the evolute of a conic section, instead of the involute of a circle, and you may well ask me how two such different methods can possibly agree. The answer is, that either cusp is a refinement on the metacentric point, and that their variable elements are determiued from the ship itself, so that within reasonable limits of heeling, the curves which they trace out do not sensibly differ from one another, neither do the mechanical results which follow from them.

Besides this, Professor Rankine's method gives the departure from isochronous rolling, and it may be as well to notice in this place that no ship of ordinary form approaches at all to the condition of isochronism. That condition is, that the centre of weight should be at the centre of the circle from which the involute is drawn. Now, in the examples which have been tried in the School, the centre of the circle came out considerably below the keel of the ship. This is an impossible place for the centre of weight, which is usually not far from the actual water-line.

I have still to explain the way in which this second approximation (regarding the metacentre as a first approximation) is obtained and applied. If our object were to draw the representative curve of a ship's stability with a penning batten, the simplest idea would be to find another point on it. But, as has already been observed, it is not that, but the mechanical property which is primarily wanted. For this purpose I give the ship a definite inclination, by what is tantamount to shifting her weights internally. I then find a new metacentre for this position, as if she were an unsymmetrical ship, masted and loaded for this skew water-line. The want of symmetry makes the calculations slightly different from the usual ones, and their exact nature will be stated in the appeudix. All I need state here is that our object is, first, to find the moment of inertia of the skew plane of flotation about a longitudinal axis passing through its centre of gravity; and, secondly, to divide this by the displacement, which remains constant. We then introduce this into some simple formulæ for work. These formulæ involve the sine of the inclinatiou and the arc corresponding to the sine, but they are exceedingly easy to use, and also to apply to any other inclination than the one calculated for.

We have still to determine our skew flotation, subject to the condition that the displacement shall remain unaltered. For this purpose I use the mean section of the ship, which I obtain as follows:—The ordinary calculations give me the areas of all the level sections. I divide these by the whole length of the ship on the water-line, and use the quotients as ordinates for setting off the mean section. It is obvious that, so far as regards displacement, upright, this is really an exact mean section, aud is equivalent to the transverse section of a prismatic or cylindrical body whose displacement at all upright flotations exactly corresponds with that of the ship. Now, for skew displacements, it is a very good approximation, and as such I use it for drawing a skew water-line. I draw upon this mean section a skew water-line, true to the required angle, but by gness as to the point at which it crosses the middle line, or line of symmetry. Then I measure the immersed and emersed triangles (a very mnch easier thing than the in-and-out wedges), and correct it if these disagree, I then transfer the line to the body plan, and run off my ordinates.

The appendices will contain full explauations of the mathematical part, and also the practical working details, with an example. One of the appendices will contain a geometrical method of exhibiting the statical stability at all angles, and for all positions of the centre of weight, provided the draught of water remains constant. The question of the (so-called) dynamical stability—that is to say, the work done in heeling the vessel through a given angle—will also be treated. I do not go into this snbject before the meeting, because it is a bit of mere mathematical curiosity, which has hitherto received no useful application, although some fanciful comparisons have been occasionally derived from it Still, it may become of real use some day; and as it is very easy to get at, it would be a piece of idleness to neglect it altogether.

I now come to the loose points in the process, and I must first say that I don't think the approximation is one of them. The mean section is very good, as I think, and so is the use made of the further condition derived from the skew metaceutre. I freely admit that they are not, in theory, so accurate as the "ins and outs," or wedge methods. But I am of opinion that the new method is as accurate as the measurements can be. For, be it remembered, that these are not taken from a ship as she sits in the water, but from a sheer draught, of which some points only have been settled by the designer, or else taken off from a ship in dry dock, aud all the rest of the drawing has been, as it is called, *faired;* that is to say, settled arbitrarily by the draughtsman. Now, if the theoretical method of calculation be as accurate as the drawiug off which it is to be taken, I don't think I need do anything more than appeal to its facility.

If the data were sufficiently accurate, it is certain that the method of the "ins and outs" ought to give us very much more information than has ever been exhibited by means of it. But it is these data which fail; and as its labour exceeds that of the new methods, in so far I think it iuvolves "lost work."

Before coucluding, allow me to point out to the younger gentlemen present the directiou in which our calculation about statical stability are chiefly defective. I will not say that our direct methods have no room for improvement, but having regard to their now very simplified form, and to the complex uature of the surfaces involved, it is clear that there can be but a very small margiu of saving to be effected by working in the direct line hitherto followed. Now, our existing work fails in this—that a ship at two different draughts is two ships, and a ship at the same draught, but with two different trains, is agaiu two ships—for all purposes of the calculation of statical stability. Every difference of draught or trim puts us through a fresh calculation. It might be imprudent to prophesy that it is in this direction that the next discoveries will be made; but I hazard nothing in telling my younger friends that here at least they will find uubroken ground.

Appendix I.—On a New Method of Calculating the Statical Stability of a Ship. By Charles W. Merrifield, F.R.S., Priucipal of the Royal School of Naval Architecture.

The time required for the calculations of the stability of ships has practically restricted the ordinary draughtsman to the use of the metacentre. This implies that the locus of the centres of buoyancy cuts the transverse midship plane in a curve which may be treated as a circle; and this is only true in general, for very small limits of inclination. In some particular cases it has been felt desirable to supplement this by computing the moment of stability at some definite angle of inclination, by means of the "ins and outs," or immersed and emersed wedges. But this has only been applied to one selected inclination, generally of 10° or 14°; and, owing partly to this, and partly to the very scant time left available to the skilled draughtsman or calculator, this has never been a part of the ordinary work of the computation of a ship's quantities. For this reason it becomes of great consequence to find some method of getting at the stability, with an amount of extra work which should not exceed that of the ordinary sheet known as the "sheer-draught calculation." *

A method has occurred to me by which, I think, this object may be attained. Upon conferring with some of my students,† who have suggested and removed certain difficulties of detail, we think we see our way, by an easy calculation, to place the whole accouut of a ship's statical stability iu the hands of any person who understands simple equilibrium, either iu an algebraical or geometrical form, as he may prefer.

It will take some time, with my present occupatious, to prepare detailed examples; but as the method is complete iu respect of principle, I have thought it best to bring it at once before the Society.

The fuudamental assumption is, that the locus of the centres of buoyancy can be sufficiently represented by a conic. The stability is then measured by the perpendicular, from the centre of actual weight, on the normal due to the iucliuation. The chief step, therefore, is to find the conic, of which I may remark we already know the vertex, and the tangent and curvature at the vertex; for these are given by the ordinary calculation of the ceutre of buoyancy and the metacentre. Now, I observe that the couic is completely determined if we can find the length of another radius of curvature corresponding to a known inclinatiou. This is obtained by finding the moment of inertia about one of its priucipal axes (longitudinal) of the plane of flotation at the iucliuatiou. This, divided by the unaltered displacement, gives the radius of curvature required.

* See "Shipbuilding, Theoretical and Practical," by Watts, Rankine, Barnes, and Napier, p. 46, for the sheer-draught calculation commonly used in this country.

† Messrs. Deadmau Edgar, John, aad White.

But the chief practical difficulty lay in finding the means of drawing an inclined water-line across the body plan, so as to give an unaltered displacement. This I have at length succeeded in overcoming, as follows:—

The sheer-draught calculation gives us, *inter alia*, the areas of the level sections, belonging to the upright position, as rectangles. Now, if we make one side of each of these equal to the length of the ship, their breadths form a series of ordinates for a curve of mean section; that is to say, the transverse section of a cylindrical body, of which the displacement at any level immersion will be the same as that of the ship. We then make out a scale of displacement for this section at various immersions, for a selected inclination, taking care to measure the immersions on the middle line of the original body plan. By this means the finding of any water-line at the selected inclination is reduced to a problem of plane geometry; and it is obvious that the place of the water-line so found will be a very close approximation to that of the required plane of flotation in the ship.

The calculations are as follows:—

1. Take out the horizontal areas from the sheer-draught calculation, and divide each by the ship's length. Set them off right and left from a vertical line at their present vertical interval, and draw a curve through their ends.

2. Any practised draughtsman will have little difficulty in drawing, at sight, an inclined line of flotation which shall give an unaltered immersed area on this mean section. He can verify it by measuring the immersed and emersed triangles obtained by his first guess, and make the correction due to the difference, if they do not agree.

3. In strictness, the more accurate course would be this—through each of the vertical stations draw right lines at the selected angle. Thence, by Simpson's rule, form a scale of areas, ending at the highest inclined water-line. Use the vertical interval of the upright displacement, and neglect the cosine of the inclination Then divide the upright displacement by the ship's length and by the cosine of the inclination, and find to what immersion this displacement corresponds in the scale of inclined areas. But this is needless, unless the calculations have to be made for different draughts of water.

4. Use this immersion to draw the inclined plane of flotation in the body plan.

5. Calculate the area, common moment, and moment of inertia of this plane, about the longitudinal axis formed by its intersection with the original plane of flotation upright.

6. Transfer this moment of inertia to the longitudinal axis passing through the centre of gravity of the inclined plane of flotation.

7. Divide the moment so found by the displacement. This will give the radius of curvature of the locus of the centres of buoyancy, corresponding to the selected inclination.

The conic is now implicitly determined. It remains to show what use is to be made of these data.

Let $\rho\theta$ be the radius of curvature, corresponding to the angle θ, made between the normal and axis of a conic; then

$$\rho\theta = \frac{a\,(1-e^2)}{(1-e^2\sin^2\theta)^{\frac{3}{2}}},\ \rho_0 = a\,(1-e^2).$$

From these we obtain

$$e^2 = \frac{\rho\theta^{\frac{2}{3}} - \rho_0^{\frac{2}{3}}}{\rho\theta^{\frac{2}{3}}\sin^2\theta} \quad \dots\dots\dots \quad (a)$$

$$1-e^2 = \frac{\rho_0^{\frac{2}{3}} - \rho\,\theta^{\frac{2}{3}}\cos^2\theta}{\rho\,\theta^{\frac{2}{3}}\sin^2\theta} \quad \dots\dots\dots \quad (b)$$

$$a = \frac{\rho_0\rho\,\theta^{\frac{2}{3}}\sin^2\theta}{\rho_0^{\frac{2}{3}} - \rho\,\theta^{\frac{2}{3}}\cos^2\theta} \quad \dots\dots\dots \quad (c)$$

$$ae^2 = \frac{\rho_0\left(\rho\,\theta^{\frac{2}{3}} - \rho_0^{\frac{2}{3}}\right)}{\rho_0^{\frac{2}{3}} - \rho_\theta^{\frac{2}{3}}\cos^2\theta}; \quad \dots\dots\dots \quad (d)$$

and these afford the means of calculating all the elements of the conic.

Now, let us take any other inclination: we may calculate ρ_ϕ from the foregoing value of e^2 by means of the formula

$$\rho_\phi = \frac{\rho_0}{(1-e^2\sin^2\phi)^{\frac{3}{2}}} \quad \dots\dots\dots \quad (e)$$

Now, if λ be the distance of the centre of gravity of the ship below the metacentre of the upright position, and p the perpendicular from the centre of gravity on the normal of the conic in the inclined position, we shall have

$$\frac{p}{\sin\phi} = \lambda + \frac{\rho_0^{\frac{2}{3}}\left(\rho\,\phi^{\frac{2}{3}} - \rho_0^{\frac{2}{3}}\right)}{\rho_0^{\frac{1}{3}} + \rho_\phi^{\frac{1}{3}}\cos\phi} \quad \dots\dots\dots \quad (f)$$

and $p \times$ D is the moment of stability, D being the displacement.

Strictly it is only necessary to use the formulæ (a), (e), (f), in actual work. Formula (f) shows clearly how an alteration in the position of the weights affects the stability. If λ be altered, the altered value of p is obtained (geometrically) by a very obvious construction.

In Mr. Scott Russell's treatise on "Naval Architecture," p. 604, it is shown how the stability may be obtained by geometrical construction when the conic is known.

It is worth while to remark that the condition that the conic should be a hyperbola, a parabola, or an ellipse, is—

$$\rho_0 <, =\ \text{or} > \rho_\theta \,.\, \cos\theta;$$

and whether the eclipse is referred to its major axis, becomes a circle, or is referred to its minor axis, depends upon whether

$$\rho_0 <, =, \text{or} > \rho;$$

θ having any value whatever within the limits of continuity.

It is to be observed that this method only applies on the supposition that there is no abrupt discontinuity. The immersion of the gunwale, for instance, would vitiate it. But in ordinary ships experience leads to the conclusion that a conic would be a very accurate representation of the locus of centres of buoyancy within all reasonable limits.

I have not waited to try the method throughout upon a specific example. But every step is separately well known; most of the steps familiarly so, within my own experience. My estimate of the extra amount of work is, that it would be rather less than would be involved in making an independent calculation of the ordinary sheer-draught work. I shall have an immediate opportunity of verifying this in my school; but I wished to announce the method publicly before beginning to teach it.

APPENDIX II.—NOTE ON MR. MERRIFIELD'S NEW METHOD OF CALCULATING THE STATICAL STABILITY OF A SHIP. By W. J. MACQUORN RANKINE.

On the 24th of January, 1867, a paper was read to the Royal Society by Mr. C. W. Merrifield, F.R.S., Principal of the Royal School of Naval Architecture, showing how, by determining the radii of curvature of the locus of the centre of buoyancy, or "metacentric involute," of a ship in an upright position, and at one given angle of inclination, a formula may be obtained for calculating to a close approximation her moment of stability at any given angle of inclination, on the assumption that the metacentric involute can be sufficiently represented by a conic.

It has occurred to me that the latter part of the calculation in Mr. Merrifield's method might be simplified by assuming for the approximate form of the metacentric involute not a conic, but the involute of the involute of a circle; the locus of its centres of curvature, or "metacentric evolute," being assumed to be the involute of a circle.

The involute of the involute of a circle is distinguished by the following property. Let r be the radius of the circle, ρ_0 that radius of curvature of the involute of the involute which touches the involute at its cusp, and ρ another radius of curvature of the same curve, making the angle θ with the radius ρ_0; then

$$\rho = \rho_0 + \frac{r\,\theta^2}{2} \quad \dots\dots\dots \quad (1)$$

Having found, then, the radii of curvature of the metacentric involute in an upright position, and at a given angle of inclination θ_1, let ρ_0 and ρ_1 be those radii respectively; then make

$$r = 2\cdot\frac{\rho_1 - \rho_0}{\theta_1^2} \quad \dots\dots\dots \quad (2)$$

This will be the radius of the required circle; and its positive or negative sign will show whether it is to be laid off downwards or upwards from the metacentre. For any given angle of inclination, the radius of curvature of the metacentric involute will be given by equation 1, which may also be put in the following form:—

$$\rho = \rho_0 + (\rho_1 - \rho_0)\frac{\theta^2}{\theta_1^2} \quad \dots\dots\dots \quad (3)$$

Let λ be the depth of the ship's centre of gravity below her metacentre, and p the perpendicular let fall from that centre of gravity upon the radius of curvature of the metacentric involute at any given angle of inclination θ; then

$$p = (\lambda - r)\sin\theta + r\,\theta; \quad \dots\dots\dots \quad (4)$$

and the moment of stability is

$$p \times \text{Displacement} \quad \dots\dots\dots \quad (5)$$

It is obvious that the condition of *isochronous rolling* is, that $\lambda - r = 0$; that is to say, that the centre of the circle which is the evolute of the metacentric evolute shall coincide with the ship's centre of gravity; a proposition already demonstrated by me in a paper read to the Institution of Naval Architects, in 1864.

INSTITUTION OF ENGINEERS IN SCOTLAND.

ON THE COMPARATIVE STRENGTHS OF LONG AND SHORT STRUTS.

By JAMES MACCALLUM.

This method of finding the strengths of long struts is but the geometrical expression of the principle first suggested by Tredgold, applied by Gordon, and

elaborated by Rankine, viz., that in a strut one part of the greatest stress is that due to the direct crushing uniformly distributed over the cross section, while the remainder is due to the bending action produced by the strut diverging laterally, thus relieving the crushing force on one side, and intensifying it on the opposite side. The formulæ, to which the application of this principle leads, although not complex, are found irksome in practice, more especially in the designing of struts, as the method of trial and error (which has to be used) involves the necessity of making the calculations two or three times over; and, besides, considerable care has to be taken in giving the proper values to the different quantities which enter into the calculation. It was the meeting with such trivial difficulties which first suggested the method given below, but perhaps its greatest use is the assistance it gives in forming clear conceptions on the subject of resistance to crushing by bending.

The questions which are here solved graphically are—

(*a*) Given the length, breadth, and sectional area of a long strut, what is the sectional area of a short strut, which would be of the same strength as the given long strut? And the sectional area thus found being multiplied by the crushing strength of the material (as found by experiment, and recorded in tables of strength), will give the crushing strength of the given long column.

(*b*) And conversely, in designing a strut of a given length, to withstand a given crushing load; that load divided by the crushing strength of each square inch (as given in tables), will be the sectional area required for a short strut; but what would be the necessary area for the long strut?

These are the questions which are to be answered; and, to begin with the case which is perhaps of most frequent occurrence, and which is also the simplest, viz., that of a solid cylindrical wrought-iron rod, for example, let it be required to find the crushing load of a wrought-iron rod 5ft. 3in. long, and 1¾in. diameter (see Fig. 3). Draw $\overline{\text{o h}}$ = 1¾in., at h erect a perpendicular whose length is the length of a rod (5ft. 3in.) to the scale of ¼in. to the foot, and along it make $\overline{\text{o h}}$ equal to the base; from the point thus found draw $\overline{\text{h h}'}$ perpendicular to the base, intersecting the latter in the point h′; then $\overline{\text{o h}'}$ is the diameter of a short rod of equal strength to the given long rod.

Constructions for finding the cross sections of short struts of the same strength as long struts, and *vice versa* :—

In all the following constructions,

$\overline{\text{ob}} = b$ the breadth of section } as marked on sections Nos. 1 to 9.
$\overline{\text{oh}} = h$ the thickness of section }

os and the area of the section.

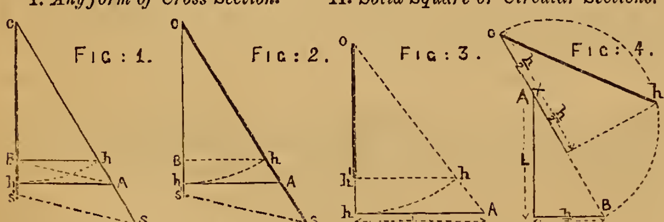
These three are the dimensions of the long strut.

$\overline{\text{ob}'}$ = the breadth of section } of the short strut of equal strength
$\overline{\text{oh}'}$ = the thickness of section } to the long strut.
$\overline{\text{os}'} \propto$ the area of section }

L is found as directed on the back of scales A and B.

The data are drawn in light lines.
The results are drawn in heavy lines.
The lines of construction are dotted.
Two lines of construction which are parallel are distinguished by the same kind of dotted line.

I. *Any form of Cross Section.* II. *Solid Square or Circular Sections.*

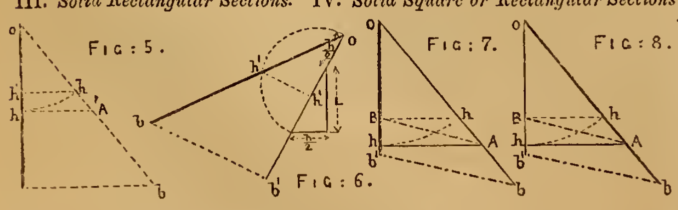


Given h × s, Required s′ — Given h × s′, Required s — Given h, Required h′ — Given h′, Required h

At the $\left\{ \begin{matrix} \text{ends} \\ \text{middle} \end{matrix} \right\}$ the thickness may be made $\left\{ \begin{matrix} h' \\ h \end{matrix} \right\}$

N.B. The scale for solid circular cross sections is ⅛″ = 1ft nearly.

III. *Solid Rectangular Sections.* IV. *Solid Square or Rectangular Sections*

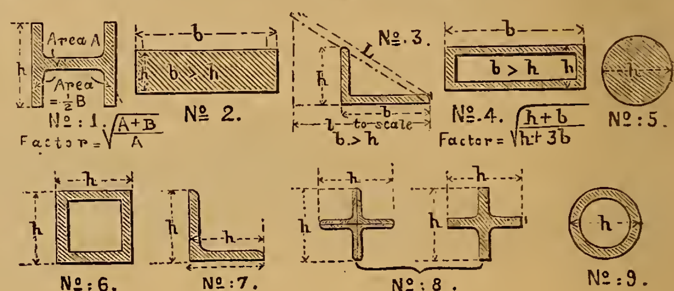


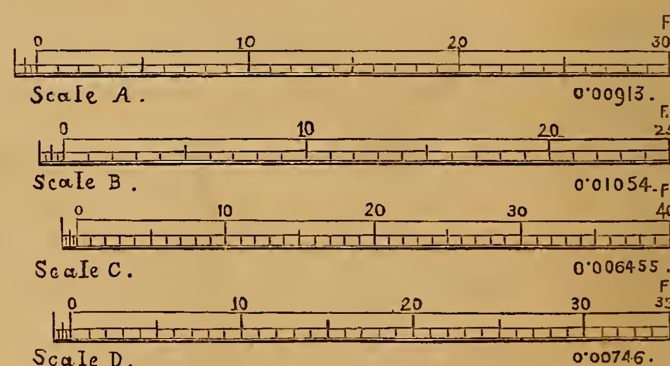
Given b × h, Required b′ × h′ — Given b′ × h′, Required b × h — Given h = h′ × b, Required b′ — Given h = h′ × b′, Required b

At the $\left\{ \begin{matrix} \text{ends} \\ \text{middle} \end{matrix} \right\}$ the cross sectional dimensions may be made $\left\{ \begin{matrix} b' & h' \\ b & h \end{matrix} \right\}$

In struts of uniform thickness *h*, the breadth at $\left\{ \begin{matrix} \text{ends} \\ \text{middle} \end{matrix} \right\}$ may be $\left\{ \begin{matrix} b' \\ b \end{matrix} \right\}$

This exemplifies the method of obtaining the strengths of struts whose dimensions are given, but the designing of struts of a given length, and to just withstand a given crushing load, is a somewhat more difficult problem. Let it be required to find the diameter of a cylindrical rod 5ft. 3in. long, which will just crush with a given load. The required diameter of a short rod is readily found. Draw a straight line half the length of this diameter (see Fig. 4); at one of its extremities erect a perpendicular equal to the length of rod drawn to the scale of ⅛in. to the foot, draw the hypothenuse of the right-angled triangle, and produce it through the vertex to o, making the part so produced equal to half the given diameter of the short rod; along the hypothenuse from o (towards the vertex) lay off $\overline{\text{o h}'}$ equal to the given diameter of the equivalent short rod; and upon the hypothenuse produced to o describe a semicircle. Lastly, at the point h′ erect a perpendicular intersecting the semicircle; the length of the line joining that point with o will be the required diameter of the rod. By the measurement, it is found to be exactly 1¾in. As there is no bending action at the ends, the diameter there might be 1½in., while the diameter at the middle remained 1¾in.. or perhaps it would be more philosophical to make it rather more than 1¾in., to compensate for the slight diminution of stiffness caused by turning off the metal at the ends; but, practically speaking, that extra metal adds little to the strength of the rod. The scale to which the length is set off is rather more than ⅛in. to the foot, and is scale B of the accompanying set. But that part of the greatest stress which is due to bending, is affected by the form of cross section, and hence the necessity for using different scales for every different form of cross section. Thus scale A is suitable for solid, square, or rectangular sections; scale B for circular sections; scale C for thin, hollow, square sections; and scale D for thin, hollow, circular sections. Further, the method of demonstration indicated below shows that an ⌊ iron, say 2ft. long and 3in. leaf, is just as much weakened by reason of its length as a thin hollow square strut 1ft. long and 3in. square; hence the scale for the latter can be made use of for the former by simply doubling the length of strut. This shows the use to be made of the factors given on the scales.





The experiments of Mr. Hodgkinson have shown that if a strut be jointed at the ends (as in connecting rods), or otherwise so fixed that it is free to bend, its strength is the same as that of a short strut of half the length, firmly fixed in direction at each end; while a strut fixed in direction at one end only, and jointed at the other (or at all events free to move at that end), is of the same strength as a strut three-fourths of its length and fixed at each end. These scales being suitable for struts fixed at both ends, can be adapted to struts fixed at one end only, by multiplying the length by ⅔, and to struts jointed at both ends by multiplying by 2.

When we have to deal with struts of other materials than wrought-iron, we have little difficulty in adapting this method to suit our purpose. Experiment has shown that cast-iron and timber struts are weakened by lengthening them somewhere between three or four times as much as wrought-iron is weakened. The proportion adopted by Professor Gordon for cast-iron is 3·35; that adopted by Professor Rankine for dry timber is 3·46.

The examples given in Articles 3 and 4 will sufficiently illustrate the other figures; but it may be added, that in finding the strengths of every kind of strut (except, perhaps, those of solid, square, or circular sections), whose dimensions are given, fig. 1 will be found the most useful, while, in designing long struts, the whole of the figs. 2, 4, 6, and 8, will be found of use. Fig. 6,

although stated to be for solid rectangular sections, will be found useful in desiguing all irregular sectious, such as L iron, H iron, &c., the precaution being taken to increase the thickness of metal in the same ratio that b' has been increased to b, aud h' to h. But as this would often lead to uneven measurements, it has been found better in practice to use fig. 6 as a guide to assist in fixing upon the transverse dimensious, verifying by fig. 1.

In demonstrating these constructions, the formulæ arrived at by Professor Rankine will be assumed. Their demonstration is given in his "Applied Mechanics," and exteuded in his "Manual of Civil Engineering." For struts fixed at each end, it is shown that

$$\frac{P}{S} = \frac{f}{1 + \frac{l^2}{c\,r^2}} \qquad (1)$$

when P is the crushing force on the strut of length l, least radius of gyration of cross section r, and sectional area S. Let h be a dimension of cross section measured perpendicular to the axis of the least radius of gyration, and therefore proportional to r and b, a cross sectional dimensiou measured perpendicular to h; c is a constaut, peculiar to each material; and f is the resistance to direct crushing of unit area.

Aud, further, let S′ be the sectional area of a short strut of equal strength to the preceding long strut, b' and h' transverse dimensions of the short strut corresponding to the preceding dimensions of the long strut, then plainly—

$$\frac{P}{S'} = f \qquad (2)$$

$$\text{Whence } \frac{S}{S'} = \frac{c\,r^2 + l^2}{c\,r^2} = \frac{r^2 + a^2\,l^2}{r^2} \qquad (3)$$

where for brevity a^2 is put for $\frac{1}{c}$

Now since $r \propto h$ $\quad r = n\,h$ $\quad$ equation (3) becomes

$$\frac{S}{S'} = \frac{h^2 + \frac{a^2}{n^2}\,l^2}{h^2} = \frac{h^2\,n'^2\,l^2}{h^2} \qquad (4)$$

where $n' = \frac{a}{n} = \frac{1}{n\sqrt{c}}$ and in the notation used on these scales,

$L = n'\,l$, so that equation (4) may be written:—

$$\frac{S}{S'} = \frac{h^2 + L^2}{h_2} \qquad (5)$$

In Figs. 3, 4, 5, and 6, $\frac{S}{S'} = \frac{h_2}{h_1} = \frac{b_2}{b_1{}^2}$ wherefore (from equation 5),

$$\frac{h}{h'} = \frac{b}{b'} = \frac{\sqrt{h^2 + L^2}}{h} = \frac{\overline{oA}}{h} \qquad (6)$$

Or o A : o h :: o h : o h′
and o A : o h :: o b : o b′

which two proportions are easily seeu from the similarity of the triangles.

To demonstrate the construction in Fig. 1.

$$\text{Equation (5) becomes } \frac{S}{S'} = \frac{\overline{oA}^2}{\overline{oh}^2} = \frac{\overline{oA}}{\overline{oh}} = \frac{\overline{oh}}{\overline{oB}} = \frac{\overline{oA}}{\overline{oB}} \qquad (7)$$

or $\overline{oA} : \overline{oB} :: \overline{os} : \overline{os'}$ the demonstration of Fig. 1,

and conversely $\overline{oB} : \overline{oA} :: \overline{os'} : \overline{os}$ the demonstration of Fig. 2.

The demonstrations of Figs. 7 and 8 are the same as those for Figs. 1 and 2 substituting b for S, b' for S′, o b for o s, and o b′ for o s′.

To demonstrate Figs. 4 and 6. The solution of equatiou (6) for h gives—

$$h^2 = h' \left\{ \left[L^2 + \left(\frac{h'}{2}\right)^2 \right]^{\frac{1}{2}} + \frac{h'}{2} \right\}$$

or h is a mean proportional between h' and $\left[L^2 + \left(\frac{h'}{2}\right)^2 \right]^{\frac{1}{2}} + \frac{h'}{2}$

$$\text{But } AB = \left[L^2 + \left(\frac{h'}{1}\right)^2 \right]^{\frac{1}{2}} \qquad \overline{oA} = \frac{h'}{2}$$

$$\therefore \overline{oB} = \left[L^2 + \left(\frac{h'}{2}\right)^2 \right]^{\frac{1}{2}} + \frac{h'}{2}$$

and $\overline{oh}$ is plaiuly a mean proportional between $\overline{oB}$ and $\overline{oh'}$ $\therefore \overline{oh} = h$, *Q.E.D.*

To find the length of the line L used in constructious:—

1. Multiply the length of strut by the factor marked on the scale. (This is not required for the sections Nos. 2, 5, 6, and 9; section No. 3 will be cousidered separately.)

2. If the strut is of wrought iron fixed at each end, pass on to (3); if not convert the length found in (1) into the equivalent leugth of a similar wrought iron strut fixed at each end, by means of the table below.

3. The length thus found laid off to the proper scale, will be the length L to be used in the constructions.

Table for converting the lengths of struts into the equivalent lengths of wrought iron struts fixed at each end.

Wrought Iron.						Cast Iron.						Dry Timber.					
Both ends fixed.		One end fixed, other end jointed.		Both ends jointed.		Both ends fixed.		One end fixed, other end jointed.		Both ends jointed.		Both end fixed.		One end fixed, other end jointed.		Both ends jointed.	
ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	iu.	ft.	in.	ft.	in.	ft.	in.	ft.	in.
	1		1½		2		3½		5		7		3½		5¼		7
	2		3		4		6¾		10	1	1½		7		10½	1	1¾
	3		4½		6		10	1	3	1	8		10½	1	3½	1	8¾
	4		6		8	1	1½	1	8	2	2¾	1	1¾	1	8¾	2	3¾
	5		7½		10	1	4¾	2	1	2	9½	1	5¼	2	2	2	10½
	6		9	1	0	1	8	2	6¼	3	4¼	1	8¾	2	7¼	3	5½
	7		10½	1	2	1	11½	2	11¼	3	11	2	0¼	3	0½	4	0½
	8	1	0	1	4	2	2¾	3	4¼	4	5¾	2	3¾	3	5½	4	7½
	9	1	1½	1	6	2	6¼	3	9¼	5	0¼	2	7¼	3	10¾	5	2¼
	10	1	3	1	8	2	9½	4	2¼	5	7	2	10½	4	4	5	9¼
	11	1	4½	1	10	3	1	4	7½	6	1½	3	2	4	9¼	6	4
1		1	6	2	0	3	4¼	5	0½	6	8½	3	5½	5	2½	6	11
2		3	0	4	0	6	8½	10	0¾	13	5	6	11	10	4¾	13	10¼
3		4	6	6	0	10	0¾	15	1	20	1½	10	4¾	15	7	20	9½
4		6	0	8	0	13	5	20	1½	26	10	13	10¼	20	9½	27	8½
5		7	6	10	0	16	9¼	25	2	33	6½	17	3¾	25	11¾	34	7½
6		9	0	12	0	20	1½	30	2¼	40	3	20	9½	31	2	41	6¾
7		10	6	14	0	23	5¼	35	2½	46	11½	24	3	36	4½	48	6
8		12	0	16	0	26	10	40	3	53	8	27	8½	41	6¾	55	5
9		13	6	18	0	30	2¼	45	5¼	60	4½	31	2	46	9¼	62	4¼
10		15	0	20	0	33	6½	50	3¾	67	1	34	7½	51	11½	69	3½
20		30	0	40	0	67	1	100	7½	134	2	69	3½	103	11	138	6¾
30		45	0	60	0	100	7½	150	11¼	201	3	103	11	155	10¾	207	10¼
40		60	0	80	0	134	2	201	3	268	4	138	6¾	207	10¼	277	1½
50		75	0	100	0	167	8½	251	6¾	335	5	173	2½	259	9¾	346	
60		90	0	120	0	201	3	301	10½	402	6	207	10¼	311	9½	415	8
70		115	0	140	0	234	9½	352	2¼	469	7	242	6	363	9	484	11¾
80		120	0	160	0	268	4	402	6	536	8	277	1½	415	8½	554	3¼
90		135	0	180	0	301	10½	452	9¾	603	9	311	9½	467	8	623	6½
100		150	0	200	0	335	5	503	1½	670	10	346	5	519	7½	692	10

Example.—A timber crane jib (and therefore jointed at both euds) is 65ft. 4in long; required the equivalent length of a wrought iron jib, fixed at each eud.

ft.	in.		ft.	in.
60	0		415	8¼
5	0		34	7½
0	4		2	3¾
65	4		452	7½

That is to say, that such a timber strut 65ft. 4iu. long would proportionally be as much weakened by reason of its length as a wrought iron column would be weakeued of the same cross sectiou, 452ft. 7½in. long, aud firmly fixed at both euds.

To find L in the case of L irons with unequal leaves, proceed as follows (see diagram to section No. 3, scale A).

1. Multiply the length of strut by 1, 1½, or 2, according to the manner in which the ends of the strut are fixed, call the product l.

2. Find L as shown on the diagram.

ON VAST SINKINGS OF LAND ON THE NORTHERLY AND WESTERLY COASTS OF FRANCE AND SOUTH WESTERN COAST OF ENGLAND, WITHIN THE HISTORICAL PERIOD.

By R. A. Peacock, C.E., Jersey.

(*Continued from page* 115.)

The sentence immediately preceding the abstract of Volume II, commencing with the words *If there have been, &c.*, is entirely attributable to the author of these papers, and it was and is intended to shew the reader that the theory of the identity of Diodorus's Isle of Ictis with Saint Michael's Mount, can now only be maintained by begging the question in debate, namely, by assuming in opposition to much evidence to the contrary, that no geographical changes have taken place since Diodorus's time.

172*c*. A friend of the author's who deservedly enjoys an eminent position amongst scientific men, in his own department of science, argues that the shell *Cerithium vulgatum*, which has been dredged up in a rolled condition (though one specimen was tolerably fresh) in 15 fathoms water on the east of Jersey, and was dredged also in a rolled condition at the mouth of the Loire—is now a species proper only to latitudes as warm as the Mediterranean and Adriatic, as if he meant to affirm that it could only have flourished as far north as Jersey, so long ago as that geological period when the north of Europe was a warm climate; from which, if true, it would follow that the sinkings must have taken place many ages before the historic period. If this is his line of argument he refutes himself both by quoting Lamarck, who "gave the North Atlantic as a locality" for *Cerithium*, and Professor Sars who "recorded the discovery of a specimen inside a "codfish caught off Bergen. Now whether this means Bergen in Norway, or Bergen in Pomerania, or Bergen-op-Zoom in Holland; it is clear that *Cerithium* has very recently been found alive much farther north than Jersey. The gentleman also "believes that *C. vulgatum*, which usually inhabits large estuaries and salt marshes, once lived in such situations between Jersey and the mouth of the Loire, and that this tract has since been submerged, and consequently become unsuitable for the continued habitability of the *Cerithium*." This testimony is entirely in accordance with my conviction, namely, that the sea-bottom in both localities has sunk. Let us consider the dredging process for a moment, and we shall soon see how infinitely far short of being exhaustive, and consequently how very far the gentleman is, from being able to affirm, that *Cerithium* is not abundant *now in a living state* in the shallow sea of the French coast of the Bay of Biscay, as in the shallow seas of the French coast of the English Channel:—

a. In attempting an "exploration of the present sea-bottom, we are only able, at considerable expense, with some personal discomfort, and in such weather as we too frequently meet with in this climate, to scrape up with the dredge a few bagfuls of sand or mud mixed with shells; nor can we hope to examine in this way more than a very few inches in depth. Many deep-borrowing shell-fish altogether escape our observation, or are only procured by chance."*

b. "Both sea and land furnish instances (some of which are difficult to explain) of the periodical appearance and disappearance of certain species of mollusca in particular places. Their arrival and departure are often sudden and seemingly capricious. In the case of marine species, this phenomenon is probably the result of changes in the course of tidal and other currents, as well as of the migratory habits of fish. These currents, by accumulating or removing deposits of mud, sand, and gravel, which afford shelter and food to mollusca, conduce greatly to their congregation or dispersal. When such deposits are rapidly formed the shell-bed becomes covered up or silted; and the mollusca are entombed alive for the benefit of future geologists. When their chief enemies, the fish, desert their former quarters and migrate to another feeding ground, the mollusca then increase and multiply, being unthinned except by the tigers of their own kind, or occasionally by the curious conchologist, or by all-devouring death. The destruction of shell-beds by marine currents may account for the prevalent notion that some parts of our sea-coast (as for example South Devon), which used to yield such regular and plentiful harvests of shells to collectors, are now scarcely worth searching,—it being said that the shells have 'deserted' the coast."†

c. Taking the tract of sea east of Jersey, and bounded on the north and south by the parallels of the north-east and south-east angles of that island, and calculating from the large scale French Government chart of 1838, it has been ascertained that the tract of sea in question contains sixty-seven nautical square miles. And supposing the dredge to be a yard wide, and two hundred dredgings to have been made, each 50yds. long, giving a total of 10,000 square yards. This would amount only to $\frac{1}{27480}$ part of the whole area. How utterly far from being exhaustive!

d. The reader has already seen that the sands of the Bay of Mont S. Michel have been penetrated in several places to the depth of 50ft. without reaching their bottom, yet the hurricane of 1735 agitated them so much as to bring up vast quantities of trees with roots from the bottom of the sands at whatever depth it is, and, of course, at the same time entombed vast quantities of shell-fish of such species as were present, perhaps *Cerithium vulgatum* among others. It is therefore abundantly clear, for all these four reasons, that quantities of the living *Cerithium* may yet exist on the French coast of the English Channel, if conchologists only knew where to look for them.

The gentleman continues:—"The presence of submarine peat near the Channel Isles and in the Bay of Mont St. Michel, tends to confirm the supposition; although it is by no means certain that the submergence has occurred within the historical period, as suggested by the Abbé Manet, Mr. Peacock, and others." There are no less than three mistakes in the last half of the sentence. (1.) Abbé Manet had no idea whatever that a submergence in the sense of sinking had taken place, nor of any other cause for the loss of the land than the fatal equinoctial tide of March, 709, sustained by a terrible north wind, which he supposed rose to so great an elevation as to "submerge the land which still maintained its former level." The Abbé forgot to take into consideration, that if that had been so, the waters would have ebbed off again instead of remaining with the land beneath them from 11½ centuries, which is fatal to his theory. The Abbé therefore never supposed at all that a submergence in the sense of sinking had taken place, and this constitutes the gentleman's *first* error. Manet's words are:—"La fatale marée de Mars de l'an 709, l'une des plus considérablos qu'on eût jamais vues, et qui, par malheur, fut soutenue d'un vent de nord des plus terribles," page 11.

(2.) Like a celebrated character of old:—

"Castigatque, auditque dolos; subigitque fateri."

That is to say, the gentleman's order of proceeding is, first to castigate which was done in September, 1865, when he could not have known even a tithe of the facts. For though he had the four quarto volumes of MS. in his hands for a few minutes, he only had time to dip into one or two of them here and there. Much less had he any knowledge of the materials which have since been collected. And notably not of one curious fact, which is not even yet (May 1st, 1867), written out, but will be so, immediately. And in short, if he had only even read the four volumes of MS., he would have seen that the changes, whatever their nature, have really occurred within the Christian period. The castigation of 1865 is therefore a mistake, because it was premature, and would be matter for regret if Mr. Peacock should succeed in proving his case.

(3). The words "and others" are a mistake. Only *one other* (besides Mr. Peacock) ever even conjectured, so far as appears, that sinkings had taken place. And that other was the late Mr. J. P. Ahier, who only supposed, at haphazard, that the loss of land was caused, either by sinking, or by the melting of the Polar ice.

Thus in one way or other, all the arguments against sinking, fail when they come to be closely considered.

172*d*. April 17th, 1867. M. Delalonde, of Jersey, 8, Broad-street, St. Helier, a native of Lessay, in western Normandy, and inventor and patentee of a powerful and compact fire-engine, lends me a chart for the Channel Islands and neighbouring French coasts with text, which he says is a cutting from the French newspaper, *Journal de Coutances*, published a few years ago. The gentleman who supplied this curious chart and text to the journal is M. Quenant, (L.Q.,) of Coutances, Prefect of the Arrondissement of Coutances, and a member of the Archæological Society of Normandy.

M. Quenaut commences his interesting narrative with a detailed account of the action of the high tides on the French shores, which it is not necessary to repeat here. He then proceeds as follows in French, which I translate:—

"I have invited the readers of the "Journal de Coutances" to send me particular information which they might have about the invasions of the sea in the Cotentin;* this appeal has been understood. One has given me to understand that he has seen the traces of a road between Carteret and Jersey, that old Carteret is more than a kilomètre in the sea; another has also seen over all the shore, at low water, the traces of the forest of Sciscy, as I have myself seen at Bricqueville-sur-Mer. It has been proved by a crowd of informations which have reached me that in the disastrous tide of January, 1863, the sea has made no invasion where it met with abrupt downs (dunes). It has been reported to me that some one found near the barque which was discovered at the sluice of Carentan Roman medals and ancient varnished earthenware, signifying that the submersion of this barque was cotemporary with the Roman rule. (See on this subject the excellent work published by M. Pontanmont in the town of Carentan). The persons who by my directions have gone to see the remains of the forest which are to be met with at Bricqueville-sur-Mer, have assured me that one has found the same debris very extensive, and that the trunks of trees are very much larger than on the shore. One has assured me, also, in the English Isles, that there may be seen everywhere on the sandy shores surrounding these isles the traces of the forest of Sciscy. The tradition they represent as having been formerly connected

* "British Conchology," by J. G. Jeffreys, F.R.S., F.G.S., &c., vol. I., p. lxxxix.
† Ibid, p. 42.

* The N.W. part of Normandy extending southwards to some point between Coutances and Avranches.

with the continent, and one has assured me that there exists a charter recalling the obligation of a Jersey family to furnish the plank which should serve for the passage of the archdeacon of the Cathedral of Coutances when he proceeded to visit that part of the diocese."

VERY ANCIENT CHART OF THE CHANNEL ISLANDS AND NEIGHBOURING FRENCH COASTS.

"Finally," M. Quenaut proceeds, "M. Deschamps-Vadeville has procured me a document extremely curious, which tends to confirm all the traditions and facts stated by M. l'Abbé Lanfranc and the Abbé Manet. It is the reproduction by one of his ancestors—a geographic engineer, bearing the same name—of a chart of ancient Neustria, of the time when it formed part of Gaul-Celtic-Armoric, at the arrival of Julius Cæsar in Gaul. This chart, says the ancestor of M. Deschamps-Vadeville, gives us an idea of the subsequent invasions of the sea since the conquest of Gaul by the Romans. It is a reduced copy which I made in 1714 of an ancient chart, in tatters, creased by lines and damp, which was presented to me at Mont S. Michel by the holy Father de St. Amand. It was of 1406, *and one had used for it the letters of the 13th century, which proves that it was itself the copy of a more ancient chart.** This chart, which we reproduce with the greatest part of the legend which accompanies it, is perfectly in accordance for the coasts of la Manche, with the first memoir which we have published; and for the coasts of Calvados, with the uncovered aqueducts conducting to the hamlets or towns invaded; the waters come from the cliffs of Port and Arromanches. The shores of the islands of Alderney and Guernsey, on which the invasions of the sea have overcome much land, are at this day represented by the islets, the banks, and the reefs. The plateau of the Minquiers, which has replaced the island of Selsouef, destroyed by the sea, has, according to the very exact chart of M. Beautemps-Beaupré, the form of this island. The ancient Regneville, designated anew on the chart on the west, by the sign $_o$, would be, according to this chart, in the middle of the reefs of Ranquet, where I myself have seen the traces of carriage roads. This chart, the most ancient in existence, and by consequence the nearest approximation to the invasions of the sea, is therefore very probably near the truth, by its antiquity, by its agreement with the historic documents which we possess, and with the suppositions which the recent discoveries of debris of habitations and forests on our sandy shores have permitted to be made.

"The reduction of the chart which we publish was designed by M. Gosselin, acting surveyor of highways, which he has reproduced with great exactness."

M. Quenaut then gives a copy of the memorandum of M. Deschamps-Vadeville, the elder, which he calls a "Legende." I reproduce it in the original French, authenticated as it is by M. Quenaut's initials (L.Q.) at foot.

LEGENDE.

"Cette carte qui représente les costes de l'ancienne Neustrie (province de Normandie), aux temps qu'elle faisoit partie de la Gaule-Celtique-Armorique à l'arrivée de Jules César dans les Gaules, et qui nous donne une idée des envahissements subséquents de la mer, depuis la conqueste des Gaules par les Romains, est une copie raisonnée, que j'ai prise en 1714, sur une vieille carte en lambeaux, trouée par les vers et l'humidité, qui me fut présentée au Mont St. Michel, par le Père religieux de St. Amand; elle estoit de 1406, et l'on avoit pour elle employé des lettres du XIII.e siècle, ce qui prouve qu'elle avoit esté elle-mesme la copie d'une carte plus ancienne. Elle offre à la vue d'antiquaire le nom et la position de chaque ville et monument celtique, dont lacon naisance a pu arriver jusqu'à nous. Et comme j'ay eu l'avantage de bien estudier l'antiquité de mon pais, par mon savoir en langue celtique, et que j'ay fait par toute la mer qui avoisine notre belle Normandie et enveloppe de ses eaux houleuses les isles Angloises et Françoises de ces parages, des estudes de sondage et parcouru son fond dans les grandes marées, comme ingénieur-geographe pour le roy, je me suis assuré par ces nombreuses opérations, qu'il y avait utilité pour le science de la reproduire, en aiant toutefois d'en corriger les défauts qui existent grandement dans le plan géographique, l'auteur n'aiant pas, à beaucoup près, comme moi, observé les degrés de longitude et de latitude de tous les points de sa carte.—L.Q."

VARIOUS PARTICULARS OBTAINED FROM M. DESCHAMPS VADEVILLE'S ANCIENT CHART, BY MEANS OF A SCALE OF ENGLISH STATUTE MILES.

The chart contains a scale of myriametres, and it appears from the Table at the end of Herschel's "Outlines of Astronomy," and also from another Table in Beardmore's "Hydraulic and other Tables," that a myriametre = 6.2138 statute miles, and the scale for the measurements has been drawn accordingly.

The continental land is represented as commencing three miles west of the present western extremity of Alderney, and the whole breadth of land from north to south measured across the present centre of the isle is six miles. Alderney, however, is joined to the continent by a neck of land which is nowhere less than three and a-half miles broad. And northern Normandy is shown as extending from three to four miles farther into the English Channel than it does at present, all the way from Cape la Hague to the meridian of Caen, which is the eastern limit of the chart. A Roman road is shown from the east end of Alderney to the town of "Corbillo," on the east of Cape la Hague.

Guernsey, Herm, Jethou, and Sercq are all shown as one island extending much farther into the sea in all directions than the present coasts, its extreme length is 23½ miles, and its extreme breadth 14 miles. It extends 4¾ miles into the Atlantic from the south-western present extremity of Guernsey, and 3½ miles into the Atlantic from the present north-west coast of that island. It extends 5 miles north-east from the most northeastern extremity of Guernsey, and 3 miles east of Herm, and 2½ miles east of Sercq. It extends 4 miles south-east from the southern extremity of Sercq, from which point the former north-western extremity of Jersey is shown as only 3¼ miles distant. The land also extends 2¼ miles south of the present south-coast of Guernsey. The whole of this large island is called "Sarnia Fanaff."

Jersey (called "Augia Fanaff") is united to the continent by a tract of land four times the breadth of its present eastern end, and at 4¼ miles east of its north-eastern angle the position of the traditional plank for the archdeacon is shown. The land extends 4 miles west from the present coast in the centre of St. Ouen's Bay, about 3½ miles north of the present north coast, and about 5½ miles south of the present south coast of Jersey. A Roman road extends from about the centre of Jersey by the south end of St. Catherine's Bay to Portbail. On this road the plank is shown, and called "la Planche."

An island called "Selsvcff," co-extensive with the Minquiers rocks, is shown. The eastern extremity of this island is 5½ miles distant from Chausey, which forms part of the continent. An estuary extends from Avranches to a place at 12½ miles east of that town, where it is joined by another estuary, extending thence to Pontorson, all between the two estuaries being dry lands. The land extended in breadth 4¾ miles north of St. Malo, and a tract of land has been lost of from 2 to 5 miles wide, all the way from S. Malo to the meridian of St. Brieuc (called Bidovs an Traovyow), which is the western extremity of the chart. The land between Portbail and Cape la Hague extended from three to six miles farther into the sea than it does at present. Western Normandy is shown as abounding with Roman roads, and the ancient coasts are everywhere cut up by estuaries, as Cæsar says they were.

The chart measures 8.83 inches from E. to W., and 7.87 inches from N. to S. The scale is 2.02 inches to 25 English miles.

This chart substantially confirms my restoration in the first map, which, as the reader knows, was produced independently, from information gathered from Cæsar, Diodorus, Ptolemy, and other ancient writers, assisted by the hypothesis that there had been a general sinking of about 22 fathoms. If the chart is to be depended on, the sinking must have been greater than that. The reader is now in possession of all the information I possess about this curious chart, and can form his own judgment upon it.

THE SAXON CHRONICLES.

172 *e*.—I have before me a valuable octavo volume, entitled, "Two of the Saxon Chronicles parallel,* with Supplementary Extracts from the others; edited, with Introduction, Notes, and a Glossarial Index, by John Earle, M.A., sometime Fellow and Tutor of Oriel College, and Professor of Anglo-Saxon, Rector of Swanswick. Oxford, at the Clarendon Press, 1865." Published by Macmillan and Co. It contains seventy-four pages of well-considered and instructive Introduction, and he encourages us to rely on the truthfulness of the chronicles by saying, at pages 66, 67, that "the Saxon chronicles which we possess are the guarantees of the truth and fidelity of the subsequent historians, and the changeful mother tongue gives that touch of confidence which the fixed and rigid Latin, much the same everywhere, could never have imparted." It will be desirable to add a few more particulars to enable the general reader to judge for himself *in what degree of estimation these curious ancient records ought to be held.*

There are seven principal Saxon chronicles, which he distinguishes by the seven first letters of the alphabet. They are records of the *most remarkable events which occurred in England*, generally one (sometimes more) in each year, commencing with the numbers of the years themselves in chronological order. They chiefly consist of political events—very rarely a comet or an earthquake is mentioned. "The main features of the anonymous and many-handed chronicle may be seen in a high state of preservation in the Saxon Chronicles. . . . . Towards their close we have historical composition of considerable maturity" (p. 2). The two Chronicles A and E are printed entire. "These two are, in

* These italics are M. Quenaut's.

† All the French Government charts bear this gentleman's name.

* A and E, down to the year 1006 inclusive, after which 1097 is the next year in A (p. 138).

different senses, the most prominent, and challenge the largest amount of notice; the one because it is the highest source, the other because it presents the latest and largest development, and the most composite structure of the whole set" (p. 3). "To King Alfred's reign [A.D. 872 to 900] we must assign all the annals down to 449, and many inserted annals down to 731 . . . . and here we only have to do with those which are borrowed from Bede" (p. 8), of which he gives a considerable list. The annals from 455 to 634 represent the gleanings and reconstruction of the half-lost early history of Wessex, at the time of the first compilation of A in 855 (p. 9). I suppose copies of the chronicles so far were obtained, and the chronicles were then continued more or less independently of each other, at the several places named in the Tabular Statement below.

Tabular Statement.

(Extracted, except where otherwise stated, from the Rev. Mr. Earle's Introduction.)

A. *The Winchester Chronicle.*—A Saxon chronicle containing annals from before Christ 60 to the year 1070. It is a MS. in Corpus College, Cambridge, called Parker's MS., from Archbishop Parker, who gave it to the college. He ranks it first in the list of Saxon chronicles, and hesitates to judge whether it is really a MS. of the last decade of the ninth century (891). Its internal characteristics connect it with Winchester. B, C, and D are similar to A, but not identical with it.

B. *The Chronicle of St. Augustine's, Canterbury.*—A Saxon chronicle from the Incarnation to the year 977. It is one of the Cotton MSS. British Museum. He states some of its peculiarities at pp. 27 and 28.

C. *The Abingdon Chronicle.*—A Saxon chronicle from the invasion of Julius Cæsar to the year 1066. A Cotton MS. The death of Edward the Confessor is narrated with extraordinary solemnity, and the accession of Harold is noticed in terms which imply that the catastrophe of his reign was already known, p. 27. He supposes that in or about the year 1045 the community at Abingdon borrowed books from Canterbury (B) and from Worcester (D), and composed from them (C).

D. *The Worcester Chronicle.*—A Saxon chronicle from the Incarnation to the year 1079. A Cotton MS. Between the years 737 and 806 there is a large influx of material, which appears for the first time in D, and through Florence it became the heritage of all the historians.* In 1066, D goes on to tell the battle of Hastings, in which it is singular, none of the others giving an account of that decisive battle.

E. *The Peterborough Chronicle.*—A Saxon chronicle from the Incarnation to the year 1154. One of the Laud M.S.S. in the Bodleian Library. It gives seventy-five years' history beyond any of the others. In many respects this is the most important of the whole series of chronicles. It is a book of the Abbey of Peterborough, and affords copious proof of its own origin. At p. 218, King William (date 1085) was evidently preparing materials for his Domesday Book:—"Also he let write how much landes his archbishops had, and his lord bishops, and his abbots, and his earls," &c., &c., which countenances the presumed authenticity of the chronicles. Florence and E have each independent materials, yet there is still a common element. We see the contrast between the English language at Worcester and that of Peterborough, p. 43. In 1098 and 1102 are examples. In the former of these two the writer feels for the tilth on marsh lands as became a resident in the fens. *The same may be said of the notice in* 1099 *of damage caused by a high flood-tide*, p. 48. I now give a translation (where required) and word for word copy in modern English, of the accounts of the inundations of 1014 and 1099:—

"1014. And on this year on Saint Michael's-mass-even, came that great sea-flood through widely this land, and ran so far up as never before not did, and submerged many towns, and mankind innumerable number."† (p. 151.)

"1099. This year also on St. Martin-mass-day, sprang up to that exceeding sea-flood, and so much to harm did, as no man not remembered that it ever afore did, and was that same day a new moon." (p. 235.)

I have now brought down from the Rev. Mr. Earle's Book—who having been the Professor of Anglo-Saxon in the university of Cambridge, considers the chronicles authentic—a historical sketch of the Saxon Chronicles as far as the two important passages just quoted, and the narrative need not be pursued any farther for our present purpose. We have besides the seven chronicles, the Latin chronicle of Ethelweard. Florence of Worcester, the Annalist who was the most vigorous of all the Latin compilers, died in 1118, four years before the compilation of E (p. lix). Two chronicles go by the name of Simeon of Durham, who quotes Northern registers which we have no other trace of. Henry of Huntingdon was an amateur and antiquarian, and had a great fondness for the old Saxon Chronicles. William of Malmesbury aimed at being a historian of a higher order (p. lxiii). We have besides, as Annalists, Matthew Paris and William of Worcester.* It is on record, though I have not personally met with the passage except in writings of the present century, that Mount St. Michael was once five or six miles from the sea and enclosed with a very thick wood. The onus of dis-proving this statement, clearly rests with those who deny it.

* These materials are perhaps contained in E; if so, they mention no marine inundations.

† The foot notes by giving (unimportant) different readings in D and F, prove that those two chronicles also contain this important record. C gives a complete copy of the record.

* Not mentioned by the Rev. Mr. Earl.

Readers can now judge, each for himself, whether or not to accept the Inundations of 1014 and 1099 as sinkings of land partly referred to Cornwall—England being the scene of nearly every individual event chronicled, and the chronicles making no mention of the particular localities affected. The extraordinary amounts of damages done, plainly as I believe, take them out of the category of simple high tides, there being no mention of storms. The submersion of many towns and innumerable men as well as the loss of 200 acres of land at Mount St. Michael, since 1086, could be satisfactorily accounted for by sinking. On the other hand those who choose (if any) can resist this explanation; and in that case the *Insulation* of the Mount (the existence of which in 1086, Domesday Book gives no authority for believing) as well as the loss of the 200 acres—remain mysterious and unaccounted for events.

The present series of papers is now completed, and will be immediately republished in an octavo volume with introduction, index, &c.; and due notice will be given in the advertising columns of The Artizan, and elsewhere, when the work is ready.

Conclusion.

If I had been advancing some *strange* doctrine which was possibly heretical, the supposition offered in two or three quarters would have been intelligible, and laudably cautious. But I have done no such thing; quite the contrary. That "*all geological changes are due to causes still in active operation,*" is so thoroughly true that it is established as a geological axiom, and the opposition is utterly astonishing. For it would be a retrograde step, not suited to the advanced state of geological science and contrary to truth, to contend that natural elevations and depressions of land, have not occurred at all periods and all over the earth during the whole historic period. I can only lament what I believe to be the judicial blindness of those gentlemen, if they continue to oppose the reception of so large a mass of evidence, all pointing in one and the same direction; namely, to establish that vast sinkings of land have taken place as stated, and within the Christian period. There is apparently no other possible way of accounting for the facts narrated. I am not accustomed to calculate chances, but it must be many thousands of chances to one against so many facts and statements, all pointing in one and the same direction—by mere accident. For my own part, I never had the slightest doubt about the correct explanation of these events, from the very first of my taking up this very interesting subject. Yet I always diligently gathered up whatever evidences presented themselves, without caring whether they were *pro* or *con*; however it always happened that they were *pro*, and never *con*. Those who reject the theory of sinking in this matter, will, as I believe, however great their scientific reputations, find themselves in the dilemma of having rejected the only possible mode of accounting for them; it is, at any rate, well to have gathered together so many particulars, for they are very curious in themselves, and of great importance in science.

TRIAL OF THE "MINOTAUR."

The *Minotaur* was built by the Thames Iron Shipbuilding Company, Orchard-yard, Blackwall. She was laid down on Sept. 1st, 1861, and launched on Dec. 12th, 1863. Her extreme breadth is 59ft. 3½in.; length between perpendiculars, 400ft.; depth of hold, 22ft. 1in. On the 9th of September last, she made her light-draught trial of speed, drawing 23ft. 1in. of water forward, and 24ft. 1in. aft. With an indicated power of her engines of 6,316 horse, she then realised a mean speed of 14·779 knots, the mean of the engine's revolutions being 57.583 per minute. Reduced from full to half boiler power, the mean speed of the ship was 12·387 knots, with an indicated power of 3,541 horse, and mean of engines' revolutions of 47·375. The ship is the first vessel of her class that has yet been placed in commission, and is also the largest iron-clad in commission afloat. She stands on the "Navy List," with her sisters, the *Agincourt* and the *Northumberland*, as a ship of 6,621 tons. Her rig is five-masted, which may either be described as bow, fore, main, mizen, and jigger masts,—or fore, main, mizen, forward, jigger, and after-jigger masts. Four of her masts carry each a lower yard, double top-sail-yards, and a top-gallant yard. The fifth, or after jigger, carries fore and aft sails. The hull is entirely encased with armour. The armament of the ship consists of four 12½ ton and 18 6½ ton muzzle-loading rifled wrought-iron guns, mounted on the main deck on wrought-iron carriages and slides, and four other 6½ ton guns on the upper deck as chase guns. The carriages and slides for the 12½ ton guns weigh together 95½ cwt: those for the 6½

ton guns weigh 75 cwt. The 12½ ton guns throw a solid shot of 250lbs. and the 6½ ton guns one of 115lbs.; the former with a battering charge of 43lb, the latter with a charge of 22lbs. of powder. There is hardly any iron-clad afloat in the navies of Europe or America whose sides or turrets could resist Palliser shot from the *Minotaur's* guns.

The *Minotaur* was docked on the 7th of May last, and on May 10th she weighed her anchor from Spithead, and entered upon her trial trip The draught of water was 25ft. 8in. forward, and 26ft. 11in. aft. Her four-bladed screw was set at a pitch of 22ft. 2in., the length of the blades being at the periphery 1ft. 7in., and at the root 2ft. 3in. The depth from the underpart of the ship's keel to the upper edge of the screw was 24ft. 11in. The coal in bunkers and the coal on deck for the trial (steam navigation coal) was, as nearly as possible, 700 tons. Wind on the mile, light from the south-east. Water perfectly smooth. In making the circles, after the conclusion of the runs over the mile, off the east end of the island, the wind freshened to a force of from three to four. The subjoined figures give the main results of the trials with full and half-boiler power on the measured mile.

FULL-BOILER POWER.

Run, No.	Time. min. sec.	Speed of Ship. Knots.	Revolutions of Engines.
1	4 6	14·634	61·5
2	4 18	13·953	61·5
3	3 58	15·126	62·5
4	4 30	13·333	61·5
5	3 53	15·450	62·0
6	4 36	13·043	61·5

Steam pressure, 25lb.; vacuum, mean 25in. Mean speed of the ship with full-boiler power, 14·357 knots; indicated h.-p. of the engines, 6,956.

HALF-BOILER POWER.

Run, No.	Time. min. sec.	Speed of Ship. Knots	Revolutions of Engines.
1	4 20	13·846	49·5
2	6 8	9·783	50·0
3	4 19	13·900	49·5
4	9 14	9·890	50·0

Mean speed of the ship with half-boiler power, 11·897 knots.

As soon as the ship had made her last run with half power over the mile, she was steamed out from Spithead until outside the Nab Light, and with Dunnose Head broad on her beam; when she was put through her circling experiments, there not being sufficient space for the purpose between the shoals inside the island.

NOTES OF SHIPBUILDING AND MARINE ENGINEERING IN THE CLYDE.

From the annual statistical report just published by Mr. West Watson, City Chamberlain of Glasgow, "On the Vital, Social, and Economic, Statistics of Glasgow, for the year 1866" (further referred to on another page), we extract the following particulars, given under the head of

SHIP OWNING AND SHIPBUILDING.

The number of vessels enrolled in the Register of the Custom House upon 31st December, 1866, was 807, representing a tonnage of 332,353, against 815 vessels with a tonnage of 329,752 in the previous year. There has thus been a decrease of 8 vessels, but an increase of 2,601 tons. These 807 vessels include 271 steamers, with a tonnage of 98,920, and 536 sailing ships, with a tonnage of 233,433—there having been an increase of 5 steamers and a decrease of 13 sailing ships during the year.

Two hundred and twenty-two vessels of all kinds were launched on the Clyde in 1866, the total tonnage being 124,513, showing a decrease in the number of vessels from the number of 1865 of 20, and of tonnage 29,000. The total number of vessels built in Great Britain in 1865 was 1,417, of which 955 were wooden and 462 iron vessels. Six only of the wooden ships were built on the Clyde, but of the 462 iron vessels 218 were constructed between Rutherglen and Greenock. The Customs revenue collected on the Clyde amounted in 1866 to £2,480,480, the largest amount ever collected in one year. The emigration from the Clyde last year amounted altogether to 12,853, of which little more than one-half were Scotch. Three-fourths nearly of the emigrants went to the United States, and about two-thirds of the remainder to Canada.

IMPROVEMENTS IN THE HARBOUR, GLASGOW.

In addition to the formation of Windmillcroft Basin, on the south side of the river, various improvements of a more or less important character are now in progress in the harbour. The most conspicuous is the erection of a new shed on the south side, immediately below Jamaica-street Bridge. This structure, replacing the less commodious shed which formerly occupied this site, measures 500 feet in length, with a breadth over all of 53 feet. Towards the street it presents a brick wall with stone dressings at the gateways. The bricklaying is in "Flemish bond." Resting on this wall, and supported on the side next the river by a range of pillars, is a substantial iron girder roof. The shed will be provided with a suitable number of sliding gates, and altogether will afford ample facilities for the convenient transaction of shipping business. With this addition the shed accommodation for the present south side quays may be said to be complete, unless at some future time it should be found desirable to afford protection to goods on the railway terminus wharf. On the north side, again, there are sheds of improved construction as far up as York-street. On the space between York-street and Robertson-street one will be commenced at no distant date, and then there will only remain to be dealt with the shabby wooden erection which at present disfigures the bridge wharf. As to the plan to be pursued with the latter, we believe the trustees have not yet come to a decision. It is to be hoped, however, that considering the immense passenger traffic from this part of the harbour, the trustees will see their way to provide something superior to an ordinary goods shed—a place, in short, where people waiting for steamers may find protection from the weather, and comfortable sitting accommodation.

In connection with the new south side shed, there remains to be mentioned an improvement which has been made in the adjoining river wall. It appears that, owing to the deepening of the river below the foundations of the masonry, the water had got access to the interstices between the supporting piles, and was gradually washing out the earth, and leaving the structure standing, as it were, on stilts. To obviate this, a row of sheeting piles, 38 feet in length, has been driven along the front of the quay for a distance of 600ft., the heads of the piles being 12ft. below the top of the wall. At the same time the spaces between the bearing piles, from which the material was being washed out, have been filled in with concrete, so that the foundations of the wall are at once rendered secure for the present, and protected against the future action of the river. The height of the wall has been increased by two additional courses of masonry, thus raising the wharf to the level of the adjacent roadway, and doing away with the inconvenience which has been felt from the previously existing slope.

On the north side of the river a new timber wharf is in course of construction between York-street and Robertson-street. This may be considered as a continuation of the present wharf opposite the foot of Robertson-street. It will have a causewayed pavement, supported on a wooden framework, as also a crane seat and ferry stair of stone.

There have been several important launches on the Clyde during the past month, amongst which we may mention the following:—

LAUNCHES AT DUMBARTON.—LAUNCH OF THE "LOCHLOMOND."

On May 1st, Messrs. Archibald Denny, and Co. launched a handsome river paddle steamer, named the *Lochlomond*, which is intended for the Glasgow and Dumbarton trade. This vessel is in almost all respects similar to one of the same name formerly a favourite on the station. She is owned by Peter Denny, Esq., but it is probable, we understand, she will be purchased by the New Steamboat Company. The *Lochlomond* is to be supplied with engines of 60 h.p. by Messrs. M. Paul and Co., of Glasgow.

LAUNCH OF THE "SUMATRA."

On May 6th, Messrs. W. Denny and Bros. launched from their south building yard a splendid iron screw steamer of 2,167 tons B.M. the property of the Peninsular and Oriental Steam Navigation Company; she is to be fitted with engines of 500 horse-power nominal on the direct-acting surface condensation principle, furnished with Lamb's patent superheater, by Denny and Co. Her dimensions are:—Length, 305ft.; breadth, 38ft.; depth, 28½ft.; measuring 2,167 tons o.m. This vessel, except in being of somewhat greater tonnage, is in all respects the same as the *Bangalore*, noticed in THE ARTIZAN for April, as having been launched by the same builders for the company named. We may mention that this is, we understand, the largest vessel built by Messrs. Wm. Denny and Brothers, and the last they will send out from their present building yard, from which they are about to remove, temporarily, to a leased yard, and permanently to an

extensive new one belonging to the firm, and now in course of being put in order.

Launch of the "Normandy" at Govan.

On May 2nd, Messrs. Randolph, Elder and Co., launched from their shipbuilding yard, at Fairfield, Govan, the *Normandy*, a fine screw steamer of 591 tons B.M., and 60 horse-power (nominal). Her dimensions are:—Length over all 180ft., breadth, 26ft., and depth (moulded) 18ft 7in. The *Normandy* has been built to the order of D. K. McGregor, Esq., of Leith, and is intended for the East Coast of Baltic trade. Her engines, which are being supplied by the same firm, are upon their patent double-cylinder expansion principle, fitted with surface condensers and superheaters.

Launch of the "Leith" at Port Glasgow.

On May 4th Messrs Blackwood and Gordon launched from their building yard a large and handsome screw steamer for Messrs D. R. M'Gregor and Co. and James Miller and Co., Leith. This vessel, called the *Leith*, is to be employed in the Leith and Baltic trade, and is, we are informed, the largest steamer ever launched in Port-Glasgow, her dimensions being:—Length, 290ft.; breadth, 35ft. 6in.; depth of hold to main deck, 18ft. 6in.; depth of hold to spar deck, 26ft. 8in.; length of engine space, 33ft. 3in.; tonnage, 1801 o.m. Immediately after the launch the *Leith* was towed into the builders' dock alongside the yard to receive her engines and boilers, which are being made by Messrs. Blackwood and Gordon, and are on the high and low pressure principle, and of 200 horse-power nominal; cylinders respectively 5ft. and 2ft. 6in. diameter, and 3ft. 6in. stroke. There will be four horizontal tubular boilers, 13ft. 6in. long, 6ft. 6in. in diameter, and 9ft. 3in. high, with 412 tubes, and 3,020ft. 8in. heating surface.

Launch of the "Grecian" at Port Glasgow.

On May 18th, Messrs. Robert Duncan and Co. launched from their building yard, Port Glasgow, a fine screw steamer named the *Grecian*, of 850 tons B.M. Length, 210ft.; breadth, 28ft.; depth, 17½ft. Engines of 100 horse-power are to be supplied by the Finnieston Steamship Works, Glasgow. The vessel is owned by R. Little, Esq., and Messrs. Handyside and Henderson, and will form an important addition to the Anchor Line of Mediterranean steampackets.

The Saloon Steamer "Elaine."

This fine river steamer, recently launched by Messrs. Robert Duncan and Co., shipbuilders, Port Glasgow, proceeded down river, on a trial trip, on May 14th, previously to being placed on the Glasgow, Larys, and Millport station. The *Elaine* has been constructed by on the half-saloon principle, her internal accommodation being very commodious and well ventilated, while her fittings and decorations are exceedingly chaste and rich. The dimensions are:—Length, 175ft.; breadth of beam, 17ft.; and depth of hold, 7ft. 3in. She has been fitted by the old established engineering firm, Messrs. Rankin and Blackmore, of the Eagle Foundry, Greenock, with double piston rod oscillating engines (Rankin's patent) of 50 horse-power nominal; the diameter of cylinders being 2ft. 4in.; length of stroke, 3ft. 8in.; diameter of paddle wheel over floats, 13ft. 8in.; length of floats, 6ft. 8in.; breadth of ditto, 2ft.; number of ditto, 8. She has one haystack boiler, 10ft. 10in. diameter, and 13ft. high; with two furnaces, having firegrate surface of 78ft; the boiler is fitted with 518 tubes of 2¼in. internal diameter, and 3ft. 10in. long. The total heating surface is 1,562 feet; the height of chimney, above furnace bars, is 31ft. On the trial trip, the load on the safety valve was 40lbs. per square inch, the gross I.H.P. being 420. The consumption of coal per hour was 10 cwts., giving 2.66lbs. per I.H.P. per hour. The mean draft of the *Elaine*, on her trial, was 3ft. 6in., the average number of revolutions, 52; and the average of her speed with and against tide was 16½ statute miles per hour. The weight of her engines and paddle wheels is 21 tons 6 cwt. and weight of boiler, with water, 20 tons 11 cwt. The engines worked with great smoothness, there being scarcely any perceptible vibration. We have to congratulate Messrs. Rankin and Blackmore upon such a successful result, looking at the high rate of the I.H.P. as compared with the low nominal horse power of the engines; and we anticipate that this, coupled with the admirable manner in which the *Elaine* has been constructed by Messrs. Duncan and Co., will soon cause the vessel to become a favourite on the Glasgow, Larys, and Millport line.

The "Weser."

This fine steamer, the launch of which we noticed in our issue for April, went down the river on May 16th, on a preliminary trip, before being handed over to her owners; she attained under easy steam a speed of 13 knots. The *Weser*, it will be remembered, is in all respects similar to the *Bremen*, *New York*, *Hansa*, *Hermann*, *America*, *Deutschland*, and *Union*, all built by Messrs Caird and Co., for the North German Lloyd's Company's Bremen and New York line, *viâ* Southampton. The *Weser* was expected to sail on her first voyage to New York about the end of May. We understand that Messrs Caird and Co. have contracted to build one more screw of 2,600 tons, for the same company. She is intended to ply also between Bremen and New York, and will be a little larger than the *Weser*.

The French Transatlantic Company.

We understand that the paddle steamers *Washington* and *Lafayette*, belonging to the above company, and built at Greenock by Messrs. Scott and Co., are about to be sent round to Glasgow to be converted into double-screw vessels by Messrs. Robert Napier and Son. The report recently laid before the meeting of the company thus explains the reason of the alteration:—

The use of the screw procures us, for vessels of equal tonnage, a saving of about 25 per cent. in fuel, with an increase of 20 per cent. in speed. This advantage has been proved in a most decisive manner by the experiment of the *St. Laurent*, which was at first intended to have paddle-wheels, but in course of building was changed into a screw vessel. We have therefore thought that further applications of the screw ought to be resolutely carried into practice, and we have decided on ordering two new screw apparatus, which will be adapted to the *Washington* and *Lafayette*, both steamers remarkable for their excellent nautical qualities, and comfortable arrangements as passenger vessels, but too slow for present requirements.

The Recent Order for Gunboats for the Royal Navy.

Four of our Clyde Shipbuilding firms have participated in a share of the recent Government order for eight new gunboats, viz., Messrs. Randolph, Elder, and Co., and Messrs. J. and G. Thomson, (of Glasgow and Goran; Mr. J. G. Lawrie, of Whiteinch; and Mr. J. Reid and Co., Port Glasgow. This intelligence is hailed with considerable satisfaction here, as, coupled with the order received by Messrs. Napier from the French Transatlantic Company, previously referred to, a not inconsiderable impetus will be given to ship building and marine engineering on the Clyde. The following is a correct *vidimus* of the tenders given in by the various builders. The Admiralty accepted offers, starting from the lowest upwards, until the number of vessels (8) was exhausted. Messrs. Rennie withdrew their tender. The rates given are per ton, B.M.:—Messrs. J. G. Lawrie,* Whiteinch, £20; Harland and Wolf,* Belfast, £22; Rennie, London, £24; J. and G. Thomson,* Glasgow, £25 10s.; Randolph, Elder and Co.,* Glasgow, £25 15s.; Pearse and Co., Stockton, £26; J. Reed and Co.,* Port Glagow, £27 10s.; Laird,* Birkenhead, £29; London Engineering Company,* London, £29 15s.; Jones and Quigging, Liverpool, £29 16s.; Miller, Liverpool, £31 10s.; Dudgeon, London, £32; London and Glasgow Engineering Company, Glasgow, £32; Denny and Brothers, Dumbarton, £34; White, Cowes, £34; Thames Company, London, £34; Maudsley, London, £35 10s.; Green, London, £36 10s.; Wigram, London, £36 10s.; Napier, Glasgow, £37 5s.; Hill, Port Glasgow, £37 17s.

* The asterisks are for the tenders accepted by the Admiralty.

INDUSTRIAL STATISTICS OF GLASGOW.

In the interesting statistical report for 1866, just published by Mr. West Watson, City Chamberlain, it is stated that no less than 873,329,400 cubic feet of gas have been distributed in the city during the year, showing an increase of nearly 50 millions of cubic feet in comparison with the preceding year. The two gas companies have employed in the distribution the large number of 87,107 meters, showing an increase of two thousand during the year.

The import of sugar into the Clyde during 1866 has attained the enormous and unprecedented amount of 147,587 tons. Now, as the quantity imported into the whole of the United Kingdom during the same period was 530,403 tons, it follows as a simple arithmetical result that the Clyde has imported upwards of one-fourth of all that has arrived in the kingdom. The rates of duty paid for good brown sugar were from 35s. to 35s. 6d. per cwt. The amount of tea upon which duty was paid in 1866 was 5,802,719lbs., and of tobacco 2,178,228lbs. It is most remarkable that while the increase since 1855 in the consumption of sugar has been 302 per cent., and in that of tea above 68 per cent., the increase upon tobacco has been only about 36 per cent.

Mr. Watson includes in his interesting report the following tabular statements in connection with the building trades:—

WAGES OF WORKMEN IN BUILDING TRADES.

		1846.	1856.	1866.
Masons, per week of 60 hours,		22s. 6d.	25s.	32s. 6d.
Labourers,	„	15s.	16s.	20s.
Joiners,	„	22s.	24s.	30s.
Bricklayers,	„	24s.	27s.	33s.
Plasterers,	„	22s.	26s.	30s.
Painters,	„	17s.	22s. 6d.	26s.
Glaziers,	„	18s.	22s.	26s.
Slaters,	„	18s.	23s.	27s.
Plumbers,	„	20s.	22s.	26s.

COST OF BUILDING MATERIALS.

	1846.	1856.	1866.
Stones, per cubic foot	8d.	10d.	1s.
Yellow Pine, per cubic foot...	1s. 4d.	2s.	1s. 10d.
Bricks, per 1,000	22s. 6d.	22s. 6d.	22s. 6d.
Lime, per ton	20s.	22s.	25s.
Slates, per 1,000	63s.	65s.	67s. 6d.
Lead, per ton	£18	£24	£22 10s.

ROYAL COMMISSION ON TRADES' UNIONS.

THE AMALGAMATED SOCIETY OF ENGINEERS.

A Royal Commission was appointed about the commencement of March to inquire into the organisation and working of trades' unions. It consists of the following members, viz.:—Sir William Earle (chairman); Lord Elcho, M.P.; Sir E. W. Head, K.C.B.; Sir D. Gooch, M.P.; Mr. H. Merivale, C.B.; Mr. J. Booth, C.B.; Mr. A. Roebuck, M.P.; Mr. T. Hughes, M.P.; Mr. F. Harrison, and Mr. W. Matthews. Until Easter the Commission was chiefly engaged in examining secretaries and members of trades' unions and working mens' associations, but since the resumption of its labours, after the Easter vacation, it has devoted itself more particularly to hearing the evidence of employers. This part of the inquiry is, as yet, incomplete; but the evidence given by the spokesmen of the employed is sufficient to furnish a clear insight into the machinery and working of the societies in question. The following abstract of the statements made by Mr. William Allen, the secretary of the Amalgamated Society of Engineers, will give a fair idea of the organisation of this, the most extensive and flourishing of all the trades' unions of the United Kingdom.

The society was formed in 1851 of a number of societies which had previously existed, and it now numbers about 33,300 members, with an annual increase of 2,000 or 3,000. There are 308 branches—namely, in

England and Wales...............	238	branches, with	27,856	members.
Scotland................................	33	„	3,218	„
Ireland	11	„	1,371	„
British Colonies (*i.e.*, Australia, Canada, Malta, New Zealand, and Queensland)	14	„	626	„
United States	11	„	198	„
France	1	„	30	„
Total	308	„	33,299	„

All these branches are governed by one code of rules, and the members of the foreign branches are principally Englishmen. Those in France are all Englishmen. Each member pays 1s. a week, and the society has now a fund in different banks, in round numbers, of £140,000. The income in 1865 was £86,885, made up, besides subscriptions, of entrance-fees varying from 15s. to £3 10s. per member. The expenditure in 1865 was £49,172, the heads under which it was distributed being:—Members out of employment, £14,076; sick members, £13,785 14s. 9d.; superannuated members (members who are "too old to gain the ordinary rate of wages at the trade," being allowed 7s to 9s. a week each), £4,634 17s. 4d.; on the deaths of members and members' wives, £4,887; and the sum of £1,800 among eighteen members who met with accidents and were unable to follow the trade. Then there is a benevolent fund, made up of a compulsory levy on every member. It should be here remarked that a member ceasing for any reason to be a member, loses all the benefits, except those who have received the injury money, and they are entitled to the benefits on paying 6d. a week.

With respect to "trade purposes" witness stated that the average annual payment for members out of work for the fifteen years the society had been in existence, was £18,000. On being questioned as to what percentage of this money had gone through strikes or disputes, he said: "We have only had one dispute which you may call important in our trade since the commencement of the society, and that was in 1852. In the first six months of that year we expended £40,000 on a lock-out; but it was not our fault that we were out of employment; it was the fault of the employers who locked us out. We have not kept a separate account of the amount spent under this head; but, leaving that £40,000 out, I should say it does not exceed 10 per cent. as far as any strikes with our employers are concerned."

As regards the organisation and government of the society, each branch is managed by a committee, and there is an executive council, to which appeal is made against decisions of the branch committees. The executive is employed four evenings a week, and holds day meetings to hear these complaints. He considered that from two-thirds to three-fourths of the whole trade belonged to the union.

The Chairman: "Have the members of the association any objection to working with non-unionists? Is there any attempt at excluding workmen who are not members of the association from employment?"

Witness: "There is one thing very certain, namely, that we do not assist them into employment. We do all we possibly can to get our own members into employment. If what we call a non-society man obtains a situation in a shop where our members are working, we certainly do not object to his working there, so long as he is 'legal to the trade,' as we say; we would not object to his working in the shop simply because he did not belong to the union."

The Chairman: "Would you make it more disagreeable to him than it would be to a society man? There are such things, for example, as not interfering with a man, but at the same time refusing to speak to him or hold intercourse with him."

Witness: "It will depend on circumstances; if the party had committed himself in some way in connection with the trade, in all probability if he went into a shop we should put him 'into Coventry.'"

The Chairman: "That would be for his individual demerit; but my question was pointed to this—if he had only the demerit of not belonging to your society, would you do so?"

Witness: "In that case we would not."

Sir D. Gooch: "There are a large number of men in every shop who are not unionists, are there not?"

Witness: "It depends on the locality."

Mr. Merivale: "What is the meaning of your term 'legal to the trade?"

Witness: "We suppose that a man who has been five years at the trade, whether apprenticed or not, is capable of earning his livelihood at it, and has become a competent workman."

The Chairman: "What has been the effect of the union upon wages and hours, in your opinion?"

Witness: "To lower the hours of labour and to maintain a proper rate, or what we conceive to be a proper rate, of wages."

The Chairman: "Are you of opinion that there has been, by reason of the action of the union, an increase of wages that would not have occurred had the union not existed?"

Witness: "Decidedly so."

The Chairman: "And similarly with regard to the lowering of the number of hours?"

Witness: "Decidedly so."

Sir D. Gooch: "What are the union hours now?"

Witness: "It depends on the locality. In London, for instance, they are 58½ hours per week; in Manchester and that district 57½ hours per week; and in some parts about the north of north of England and some parts of Scotland 60 hours per week."

The Chairman: "Is there any prohibition as to men working overtime?"

Witness: "No, we have no rule to prevent any member from working overtime."

The Chairman: "But, adopting a phrase which was used just now, do you either deprecate it or discountenance it?"

Witness: "No, we would prefer that it was not done; but still we make no decided objection to it."

The Chairman: "Have you any objection to piece work?"

Witness: "Yes, we have a very decided objection to it, and endeavour to do away with it where we have the opportunity."

The Chairman: "In what way do you make your objection known to the workman who is inclined to take piece-work?"

Witness: "That is made known to him through the committee of management of his branch, which I have already referred to."

The Chairman: "Does it lie only in words to the effect that the society object to piece-work, or is the man fined? Is there anything more than persuasion?"

Witness: "We have resorted to other steps. For instance, if a member will persist in doing so contrary to the wish of his fellow-members, we sometimes expel him from the society."

The Chairman: "Is there any rule in the society as to unskilled workmen being employed with machinery?"

Witness: "No, not in the rules. Where we possibly can, we always like to get our own members to work the machines; but we do not, as a rule, take any action against the other parties working them."

Witness went on to state that the men were generally averse to strikes, and endeavoured to avoid them, thinking "matters ought to be settled in a different way," and the different way was by sending deputations to the masters.

On the question of piece-work, the Earl of Lichfield asked what objection there was to it, and the witness answered: "To be candid with you, and that is the best way of dealing with the question, we believe that it has a tendency to injure the trade; that is to say, that by the introduction of piece-work, and every one being allowed to use his own discretion in the matter, ultimately our wages would be brought down to something like the sweating system among the tailors; and so we endeavour to destroy the system wherever we possibly can. We believe it is not altogether a proper system; the work suffers in a great measure—it is not done in so finished and good a style as if it were done by day-work. Then, too, the wages of piece-work are generally settled by an expert workman; that is, the employers generally give a piece of new machinery, or whatever they want doing, into the hands of an expert workman, so that if he gets what may be considered a fair wage, those who are not such good hands come down to almost a starvation price. I have known instances of men on piece-work having to go with less than what an ordinary day's wages would have been, and such cases had occurred at the Royal Arsenal and other Government works."

Mr. Merivale: "Is the rate of wages really and permanently lower where piece-work prevails than the rate of wages where piece-work does not prevail?"

Witness: "No; in Manchester the wages are higher than in any other part of the district, and there piece-work exists to a very considerable extent, though not so much as formerly." And he added that the work, as a general rule, was, he thought, inferior. He hesitated to affirm this, however, and on questions by Mr. Hughes and the Earl of Lichfield, he said piece-work was carried out at the Royal Woolwich Arsenal, and there could be no question, generally speaking, about the work being well done. In some cases the Government "were good employers."

The secret rules of the society impose fines upon any member doing work by the piece and refusing to share the surplus over the weekly wages with the members upon the job; that is to say, be is forced to share the profits of his skill with the others, under the penalty of a fine of 10s. the first, 20s. the second, and exclusion the third time. If man obtains a situation for a non-

society man, without the consent of the president or officer of his branch, he is liable to a fine of 5s. Members working under a "piece-master" insist upon having a share of such profits, and those who refuse to leave such employment on the call of their branch, for not receiving such profits, over and above their wages, subject themselves to the same penalties.

Mr. Matthews: "If a workman, possessed of superior intelligence or tact, in organising a contract, divides the proceeds among his fellow men, there is no encouragement for him to proceed in that way, is there?"

Witness: "Such a man is, generally speaking, rated at a higher rate of wages than the others, and, in addition to his rate of wages, or his share in the surplus, he generally receives something like five or ten per cent. for his management of the affair, which, however, is only given at the option of the other men; and, if they decline to allow it, the skilled manager of the job must submit to go without it. The society does not interfere with a man getting more wages than the average, but it assists men in obtaining a rise—that is to say, a man may complain to his branch that he has not enough wages, and if the members think with him they will sanction his leaving and having the "out-of-work donation;" but if a man works for less than he is thought entitled to, and is willing to continue working for this less sum, he stands "a very good chance of being excluded" from the society.

Mr. Matthews: Even without working at a very reduced rate, if he were working below the recognised rate of working, the same would occur, would it not?"

Witness: We should say, 'You must leave this shop.' We will suppose a shop to be what we call a 36s. shop—that is to say, 36s. a week. If a member goes and works there for 32s., and is not worth any more, then we say to him, 'Your better plan will be to leave this shop, and go to one where you can only get that; but do not stay here for the purpose of giving encouragement to the employer to reduce the rate to 32s.'" Another of the by-laws, or secret rules, is the one prohibiting members from procuring non-members a job without first obtaining the sanction of the branch.

Mr. Matthews: "Supposing his brother came to him, would he be prohibited from recommending him?"

Witness: "Decidedly; and it is quite proper, I should say, that he should" (be so prohibited).

(*To be concluded in our next.*)

REVIEWS AND NOTICES OF NEW BOOKS.

The Engineer Officers' Navy List, and Handbook of Information for the Steam Branch of the Royal Navy. April, 1867. (Devonport: John R. H. Spry.)

The continued omission of the names of the naval engineers from the official "Navy List," pointed out and animadverted upon by Sir E. Dering, in a recent sitting of the House of Commons, has given rise to the issue of this publication. The "Engineer Officers' Navy List" contains, besides a complete list of all the members of this branch of the naval service, the whole of the memorandums, instructions, and regulations in force, respecting qualification, examinations, promotion, pensions, uniform, diet, &c. Having for many years past persistently advocated the cause of the "steam branch," we hail with pleasure the appearance of this useful publication, which has been got up in a style very creditable both to the compiler and publisher.

The French Universal Exhibition Building. The Design for the Exhibition Palace, Official and other Correspondence, &c. By George Maw, F.S.A., and Edward J. Payne, F.R.I.B.A. London: Cox and Wyman.

L'Exposition Universelle Francaise de 1867. (French translation of the above.) *Ibid.*

As far back as February 16, 1861, the authors published in our contemporary, the *Builder*, a "design for an exhibition building, with suggestions for method of classifying the proposed exhibition of 1862." This design shows an elliptical building, the space of which is divided out in annular and radial divisions, with a view to a geographical and specific association of the objects. In this, as in most other respects, the plan of the building of the present Paris Exhibition is a perfect fac-simile of Messrs. Maw and Payne's design. These gentlemen having applied to the Imperial Commission for an acknowledgment of their priority, the vice-president evaded the issue by stating that "the difficulty solved by the Imperial Commissioners' plan was not the general problem of the form, whether rectangular or elliptic, which alone was sufficient to comply with the conditions laid down by H.I.H. the Prince Napoleon in his report at the close of the Universal Exhibition of 1855, viz., the arrangement of the products at the same time by specialties and by nationalities, but chiefly in the details of execution which, to respond to the multifarious necessities of this grand assembly, required numerous practical observations, the fruit of experience collected in the preceding exhibitions." From the documents given in the above publication, it is, however, quite evident that the authors were the original designers, and the flimsy subtleties of the Commission cannot obliterate the fact that it has appropriated for its own use a plan not its own, without even doing to the originators the scanty justice of acknowledging their merits. Messrs. Maw and Payne's pamphlet is highly interesting, and we invite to it the special attention of our readers.

BOOKS RECEIVED.

"The Strains on Structures of Ironwork, with Practical Remarks on Iron Construction. By F. W. Shields, M. Inst. C.E. Second edition. London: John Weale. 1867.

"A Treatise on the Art of Constructing Oblique Walls with Spiral Courses." By William Donaldson, Associate Inst. C.E. London: E. and F. N. Spon. 1867.

"The Mechanician and Constructor for Engineers, comprising forging planing, lining, slotting, shaping, turning, screw-cutting." By Cameron Knight. London: E. and F. N. Spon. Parts i. to v.

"Etudes sur l'Exposition de 1867, ou les Archives de l'Industrie au XIX. siècle. Par MM. les Rédacteurs des 'Annales du Genie Civil." Fascicule I. May 15, 1867. Paris: Eugène Lacroix.

(*To be noticed in our next.*)

PRICES CURRENT OF THE LONDON METAL MARKET.

	April 26.	May 3.	May 10.	May 17.	May 24.
COPPER.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Best, selected, per ton ...	82 0 0	82 0 0	82 0 0	82 0 0	84 0 0
Tough cake, do.	80 0 0	80 0 0	80 0 0	80 0 0	81 0 0
Copper wire, per lb.	0 0 11¼	0 0 11¼	0 0 11¼	0 0 11¼	0 0 11¼
" tubes, do.	0 0 11¾	0 0 11¾	0 0 11¾	0 0 11¾	0 0 11¾
Sheathing, per ton	82 0 0	82 0 0	83 0 0	83 0 0	83 0 0
Bottoms, do.	88 0 0	88 0 0	88 0 0	88 0 0	88 0 0
IRON.					
Bars, Welsh, in London, per ton	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0
Nail rods, do.	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0
" Stafford in London, do.	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0
Bars, do.	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0
Hoops, do.	8 12 6	8 12 6	8 12 6	8 12 0	8 12 6
Sheets, single, do.	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0
Pig, No. 1, in Wales, do. ...	4 5 0	4 5 0	4 5 0	4 5 0	4 5 0
" in Clyde, do. ...	2 13 0	2 14 0	2 14 0	2 14 6	2 14 6
LEAD.					
English pig, ord. soft, per ton	20 0 0	20 0 0	20 0 0	20 0 0	20 0 0
" sheet, do. ...	20 15 0	20 15 0	20 15 0	20 15 0	20 15 0
" red lead, do. ...	21 15 0	20 15 0	20 15 0	20 15 0	20 15 0
" white, do. ...	27 0 0	27 0 0	27 0 0	27 0 0	27 0 0
Spanish, do.	19 2 6	19 10 0	19 10 0	19 10 0	19 10 0
BRASS.					
Sheets, per lb.	0 0 9	0 0 9	0 0 9	0 0 9	0 0 9
Wire, do.	0 0 8½	0 0 8½	0 0 8½	0 0 8½	0 0 8½
Tubes, do.	0 0 10¾	0 0 10¾	0 0 10¾	0 0 10¾	0 0 10¾
FOREIGN STEEL.					
Swedish, in kegs (rolled) ...	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0
" (hammered)	15 5 0	15 5 0	15 5 0	15 5 0	15 5 0
English, Spring	17 0 0	17 0 0	17 0 0	17 0 0	17 0 0
Quicksilver, per bottle ...	6 17 0	6 17 0	6 17 0	6 17 0	6 17 0
TIN PLATES.					
IC Charcoal, 1st qu., per box	1 10 0	1 8 0	1 8 0	1 8 0	1 8 0
IX " " "	1 16 0	1 14 0	1 14 0	1 14 0	1 14 0
IC " 2nd qua., "	1 6 0	1 4 0	1 4 0	1 4 0	1 4 0
IC Coke, per box	1 4 6	1 3 6	1 3 6	1 3 6	1 3 6
IX " "	1 10 6	1 9 6	1 9 6	1 9 6	1 9 6

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Nuisances arising from Sewage.—Lillywhite v. Trimmer (April 30).—This action was brought by the plaintiff, the owner of a flour mill, at Neatham, Hants, against the Local Board of Health. It was alleged that the defendants had constructed sewers, viz., a main one, running into the river Wey above plaintiff's mill, and branches which intercepted the rainfall and ordinary adjuncts to the river, thus fouling the water, whereby the fish had been driven away and the water rendered offensive. The town contained 4,000 inhabitants. The defendants had erected tanks for the neutralisation of the offensive matter, and the evidence as to the condition of the river was somewhat conflicting. The question was, by arrangement, referred to Mr. Bazalgette, the engineer

to the Metropolitan Board of Works, upon whose report judgment was given by Vice-Chancellor Malins. His Honour said that the principle recognised in these cases was that where for a public purpose private rights were interfered with, the latter must prevail, and the public purpose must be otherwise effected as best it could. The drainage of towns—a great public purpose—had of late created one of the great difficulties of the age, and would probably increase with the increase of population. But public objects so essential to cleanliness and health must not be wholly overlooked, and the Court ought to put no difficulty in the way of carrying them into effect. By analogy to the law as to the obstruction of light and air, there must be some material injury to be relieved against, but in this case it was clear that the plaintiff's own neglect to cleanse his water-wheel and pond had caused the condition of the water. On Mr. Bazalgette's report his Honour held that there was obviously no nuisance, and no such case had been made out as to entitle the plaintiff to relief. Bill dismissed without costs.

CROSSLEY v. LIGHTOWLER (May 2).—The plaintiffs in this case (the well-known carpet manufacturers of Dean Clough Mills, Halifax, on the river Hebble) sought to restrain the defendants from suffering the foul water from their dye-works to flow into the river, and thereby discolour the plaintiff's yarns. [For particulars see THE ARTIZAN for December, 1866.] Vice-Chancellor Wood had, in November last, granted the injunction asked for by the bill, at the same time directing an inquiry. Upon the defendants' appeal the Lord Chancellor held that the evidence did not support the whole of the Vice-Chancellor's decree. He then reversed the decree of the Court below in reference to the works of the defendants themselves, but continued the injunction to restrain the fouling of the water which passed by a piece of land purchased by the plaintiffs from the defendants. The rest of the decree was affirmed by his lordship.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation. necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

THE "GREAT EASTERN" arrived in the Mersey on the 1st of May, from New York, by way of Brest, her charter with the French company having been cancelled,—the ventnre to run between France and New York proving a dead failure. The tonnage duty on the *Great Eastern* on entering the port of New York amounted to 6,046 dols., and with the addition of harbour-master's, health officers', and pilots' fee, charges on stamps, permits, &c., being altogether only the expenses of entering the port, to 7,000 dols. She carried to Brest only 191 passengess, paying 100 dols. each, which amounted to 19,100 dols., leaving a surplus of 12,000 dols. to pay the expenses of the voyage, the salaries of her officers, crew, and attendants. The cost of repairing and painting, and other incidental items, are to still be liquidated.—The great ship has since been seized by the Receiver of Wrecks at Liverpool, upon a citation issued on behalf of some 330 of the crew, claiming about £5,000, being the amount of three months' wages.

LIGHTHOUSES.—There are six lighthouses now in process of construction by the British Government—one situated on the Little Basses Rock, at Ceylon; one on the Roman Rocks, at the Cape of Good Hope; two in the Bahamas (on Castle Island and Imagua Island); one on Sombrero Island; and one on the Bellamara Point, at Malta.

LIGHTHOUSES AT THE PARIS EXHIBITION.—In the park of the Exhibition there is a model of a first-class lighthouse, and on the banks of the Seine, just above the Pont d'Iéna, another of less power. The larger lighthouse stands on an island in a small lake, and is about 160ft. high. From the ground floor of this iron structure to the gallery round the lantern, there is a staircase of 250 steps. The lenticular apparatus is 6ft. in diameter and nearly 8½ft. high. Its lighting power is such that it will be distinctly seen at sea from a distance of a 12 leagues. This lighthouse is to be placed on the most elevated point of the Roches Donvres, an island between the Isle Bréhat and Guernsey, about 12 leagues from the Port of Portrieux (Côtes du Nord). The other lighthouse on the quay is a small octagonal iron tower, about 25ft. in height, showing a red light, visible only for two or three miles. It is remarkable for a very curious innovation, being provided with bells, which are intended to warn vessels off the coast in foggy weather.

MCHAFFIE'S MALLEABLE IRON AND STEEL CASTINGS, of which Messrs. McHaffie, Forsyth and Miller, Glasgow, are the sole manufacturers, are applicable to a great variety of engineering, shipbuilding, and architectural purposes. The metal produced by McHaffie's process possesses a remarkable durability and immunity from breakage, and forms a valuable substitute for iron and steel. Thus, a number of complicated parts of steam engines and general machinery—such as the duplex clip links of the chains of cloth-finishing machines, which it would be very difficult and expensive to make of wrought iron or steel—may, by the aid of this process, be made of almost any size or weight, and perfectly reliable as to strength and homogeneousness. The adoption of McHaffie's metal is found to result in a considerable saving, especially for parts subject to much wear and tear. Thus, a set of bevil wheels and clutches, supplied by the above firm, having been constantly at work at a high speed, for five years, and exposed to very heavy strains, it was found that scarcely any impression had been made upon them; one of these wheels figures among the specimens sent to the Paris Exhibition by Messrs McHaffie and Co. We may add here that the malleable castings referred to in our description of Mr. Alley's radial drilling machine (ARTIZAN of March last, page 51, column 1) are made of McHaffie's cast iron; indeed, the ordinary make of malleable castings are quite unsuited for such purposes. The same remark applies to confining rings and end plates for railway springs, for which, in the experience of a London firm, no other malleable castings are suited. Of the articles now made of McHaffie's metal, for marine, locomotive, and general engineering and shipbuilding purposes, may be mentioned:—screw propellers of the largest size, cross heads, connecting rods, ferrules for boiler tubes, mast caps, slide bars, hydraulic cylinders, &c. An experiment was lately made in Glasgow with a hydraulic cylinder made of this metal, with a view to prove its strength. The dimensions were.—Inside diameter, 10in.; length, 2ft. 10in.; thickness of metal, 2¼in. A pressure of three tons per square inch was put on, which the cylinder stood perfectly well; the requisite thickness of metal of a cast iron cylinder would be about 8½in. *ceteris paribus*. Long continued use, the most conclusive of all tests, having thus established the value of McHaffie's metal, we are pleased to learn that its consumption is increasing both at home and abroad.

BALLAST IRON.—The Lords of the Admiralty having decided on disposing of the stores of ballast-iron at Chatham Dockyard, better known as "Seely's Pigs," orders have been received for 2,000 tons of the iron at that establishment to be at once sold, and the proceeds carried to the public account. The tests of the ballast-iron in use at Chatham Dockyard show that there are four or five different qualities, the best kind being very valuable. The quality of the iron, however, can only be ascertained after each pig has been split asunder, to allow of the crytals being seen, and as the method in which the iron is broken has been found to materially affect its quality, the duty of breaking each of the pigs of the quantity of iron sold will be undertaken by Messrs. Ryland, who will be paid at the rate of 1s. 6d. per ton for this work, in addition to their commission on the sales. The Admiralty order also directs the sale of 2,000 tons of the ballast-iron in store at Sheerness Dockyard, an the same conditions. The circumstance of the iron requiring to be broken before it is sold will render the entire 4.000 tons useless as ballast-iron, should the Admiralty terms not be accepted. It is worthy of remark that, notwithstanding the comparatively high value of the ballast-iron, the experience of the last few years has completely proved that in a dockyard like Chatham, in which the traffic of enormous armour-plates, with the heavy slabs, plates, and iron beams used in the construction of iron ships is going on at all hours of the day, the granite tramways laid down require renewing and repairing at intervals of a few months; while, on the other hand, the passage of the heavy weights has no perceptible effect upon those portions of the yard where the tramways are laid with pigs of iron.

BAKER'S ANTI-INCRUSTATOR has, for some time past, come into extensive use in this country. An apparatus of this kind, fitted to a steam boiler at the South Metropolitan Gas Works, Old Kent-road, it stated to have prevented incrustation from gathering in any part of the boiler. We propose to give an account of the anti-incrustator in our next issue.

MILITARY ENGINEERING.

AMMUNITION FOR SNIDER'S RIFLE.—A War Office return shows that up to the 1st of March 12,439,598 service cartridges (Boxer), and 204,710 proof cartridges for Snider rifles had been manufactured at the Royal Laboratory, and there had been supplied by contract 3,049,525 empty cartridge cases, and 5,045,000 shells for percussion caps. The cost of the 12,439,598 cartidges was £49,570, but this is no criterion of the present cost. At the commencement of the manufacture there was a want of suitable machinery, and also a want of skill, and night work was adopted, and the price at first charged for metal has been reduced about 25 per cent.; the cost, therefore, is now much lessened. None of this ammunition has been condemned or broken up, but about 1,400,000 rounds of ball have been converted into blank, owing to a change in the pattern of the case.

NAVAL ENGINEERING.

A PORTABLE STEEL VESSEL, designed by Mr. E. T. Reed, chief constructor of the Navy, is to be used by the exploring party about to be despatched from this country to the interior of Africa, to search for traces of Dr. Livingstone, when completed at Chatham dockyard. The vessel is intended to be built throughout of steel and charcoal iron plates 1-16in. in thickness, and in short half sections about two feet in length (the heaviest weighing no more than 40lbs.), which may be carried overland to the lakes and rivers to be explored, and there put together with screws, bolts, etc. The keel will be formed of half-inch iron plates, and fitted with additional thin plates to act as leeboards; the vessel is intended to be fitted with a mast and a set of fore and aft sails.

THE SCREW STEAMER "ROYALIST," built by Messrs Blackwood and Gordon, for Sir James Brooke, K.C.B., Rajah of Sarawak, left Port-Glasgow in the first week of May for Borneo, and made a very successful run to Queenstown, where she put in to fill up with coals, previous to starting on her voyage,

THE PRUSSIAN NAVY consists, according to a return lately issued, of the following vessels:—Ironclads: *Arminius*, 4, 300 H.P.; *Prinz Albrecht*, 3, 300 H.P. Corvettes: *Martha* and *Vinetta*, 28 each, 400 H.P.; *Gazelle* and *Aurora*, 28 each, 386 H.P.; *Nymphe* and *Medusa*, 17 each, 200 H.P.; *Augusta* and *Victoria*, 14 each, 400 H.P. Despatch boats: *Preussischer Adler*, 4, 300 H.P.; *Loreley*, 2, 120 H.P. Royal yacht: *Grille*, 2, 160 H.P. Eight steamers of the first class, 24, 630 H.P.; 15 of the second, 30, 900 H.P. Total, 36 steam vessels, 5,482 H.P., and 243 guns. Sailing frigates: *Gefion*, 48; *Thetis*, 38; and *Niobe*, 28. Sailing brigs: *Rover*, 16; *Mosquito*, 6; and *Hela*, 6. Thirty-two gunboats, 2 guns each, or in all, 64; four, 1 gun each, 4; total, 42 sailing vessels, with 210 guns. The Prussian navy, therefore, consists of 78 ships, with 453 guns. The *Vinetta* is at this moment in the extreme East; the *Gazelle*, the *Mosquito*, and the *Rover* in the Mediterranean; and the *Niobe* at the Cape Verd Islands. Besides the above-named vessels, Prussia possesses a certain number of small sailing and steam boats which only perform the service of the ports. In course of construction she has three iron-clad frigates and one corvette, of 400 H.P.

H.M.S. "BLANCHE."—In consequence of the removal of a number of workmen from the unarmoured screw corvette *Blanche*, 6, 1,268 tons, 350 H.P., one of the new corvette class of ships building at Chatham, designed by the Chief Constructor of the Navy, the completion of that vessel will be delayed till August next, by which time she is to be ready for launching. The *Blanche* is constructed on the U shaped midships sections, which form a distinctive feature in the ships designed by Mr. Reed, carrying her bow well out of the water, with the projecting under-water stern, and her lines fined off forward. Inboard she is a most roomy vessel, while the space between decks is considerably more than has hitherto been considered essential in vessels below the frigate class. Iron as a material has been largely used in the construction of the *Blanche* wherever found practicable. Her upper and main deck beams are of rolled iron, from the Butterley Works, and her gun deck is furnished with the ordinary iron deck plates. An alteration has been made in her magazines to enable her to carry the two additional guns she is intended to have.

BUILDING v. SELLING.—Five line-of-battle ships and five first-class frigates were sold the other day for £68,000. These ten ships have an aggregate tonnage of 24,306 tons, an aggregate nominal horse-power of 4,030, and an average age of about 12 years only; the boilers and machinery of most of them are in sea-going order: indeed, one 80-gun ship has never used her engines since converted. Now, in 24,306 tons of war vessels, constructed as customary in H.M.'s dockyards, there are roughly about the following quantities of first quality *matériel*:—Oak, teak, elm, fir, &c., 17,367 tons; iron, 1,260 tons; copper, 575 tons; mixed metal, 70 tons; lead, 90 tons; and its actual market value is as follows:—17,367 tons timber, average per ton £4—£69,468; 1,260 tons iron, at £3—£3,780; 575 tons copper, at £70—£40,250; 60 tons yellow metal, at £50—£3,000; 90 tons lead, at £20—£1,800; total, £118,298. Engines, 4,010 H.P., at £4 per H.P., £16,040—£134,338. Maximum cost of breaking up ten ships, employing on each ship 100 men for 100 days, at 5s. per day, £25,000; tools, &c., £2,000—£27,000. Net proceeds, £107,338; price sold for, £68,000. Clear profit to purchasers, and loss to H.M.'s Treasury, £39,338. These quantities and prices are taken from Admiralty documents with from 10 to 20 per cent. deduction on the latter; and the original cost of the ships was about £2,000,000, to say nothing of about £2,000,000 more spent in converting them to screws.—*Globe.*

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated March 30th, 1867.

964 J. G. Jones—Getting coal aud other minerals

Dated April 1st, 1867.

965 C. D. Abel—Treating fluids
966 W. R. Lake—Closing aod fasteniog port lights of ships, &c.
967 J. Harker—Expressing oils and fatty matters
968 C. E. Brooman—Producing surfaces in relief for printing aud other purposes
969 J. Prentice—Making cigars
970 A. V. Newton—Sewing machinery
971 F. Curtis—Paper machinery
972 J. Lewis—Firearms and cartridges

Dated April 2nd, 1867.

973 H. A. Bonneville—Economising motive power
974 H. A. Bonneville—Means of readily igniting fuel
975 H A. Bonneville—Railway brake
976 B. Wolstenholme—Textile fabrics
977 J. J. Meyer and A. Meyer—Tank locomotive engine
978 W. R. Lake—Manufacturing boxes from sheets of paper, &c.
979 J. Storey, W. E. Bickerdike, and W. V. Wilson —Bronzing metallic and other surfaces
980 W. E. Newton—Centrifugal sugar machines
981 T. B. Robinson—Artificial fl wers and foliage
982 J. Shanks—Cutting the hair off horses, &c.
983 J. Mahler—Coverings for internal walls and surfaces
984 J. A. Moll—Obtaining and applying motive power
985 W. Clark—Bathing apparatus
986 W. Clark—Copying letters and manuscripts
987 W. Clark—Weaving figured fabrics
988 W. Clark—Applying aud fitting the tubes of multitubular boilers, &c.
989 J. F. Reeves—Preparation of explosive compounds, &c.

Dated April 3rd, 1867.

990 J. Pickering—Raising weights, &c.
991 J. Whitehurst and T. Walsh — Looms for weaving
992 E. H. Waldenström—Miners' safety lamps
993 J. Musgrave—Fittings for stables, &c.
994 A. S. Hallidie—Suspension bridges
995 W. Clark—Ear stoppers
996 T. Faucheux—Boots
997 P. Spence—Separating zinc from certain ores
998 J. A. Bouck—Burning petroleum, &c.
999 J. W. Scott—Needles, &c.
1000 G. E. Van Darburgh — Artificial stona for grinding, &c.
1001 A. G. Hills—Safety bridle for horses
1002 E. Delessert— Cartridges for breech-loading firearms
1003 W. Stafford and W. P. McCallum—Heating the feed water of steam boilers
1004 J. H. Barker—Milling machines
1005 J. Ogden and J. Stephenson—Steam boilers
1006 W. Hodson—Bricks, &c.
1007 W. R. Lake—Revolving breech-loading firearms

Dated April 4th, 1867.

1008 H. Davey—Obtaining motive power, &c.
1009 J. Ladley—Spinning wool, &c.
1010 W. C. Webber—Feeding bottles
1011 E. Pilling—Looms for weaving
1012 S. Perkins—Railway crossings
1013 J. Petrie—Washing wool
1014 E. Casper—Extinguishing fires
1015 J. M. Kilner—Towing ships, &c.
1016 B. Fowler—Railways and railway engines

Dated April 5th, 1867.

1017 D. Ellison—Looms for weaving
1018 H. Buss—Construction of sea walls, &c.
1019 W. Tatham and W. T. Heap—Teazing and opening fibrous materials
1020 S. Leather—Wearing apparel
1021 J. G. Tatters—Method of and apparatus for communicating between the several parts of railway trains
1022 T. B. Marshall—Insulation of subterranean electric telegraph wires, &c.
1023 W. A. Gilbee—Breech-loading fireorms, &c.
1024 F. A. Mocquard—Application of gas burners
1025 E Beningfield—Lifting machine
1026 S. Matthews—Combined lift and force pump
1027 W Adair—Pumps
1028 W. E. Newton—Steam generators

Dated April 6th, 1867.

1029 H. Wilson—Valves for discharging water, &c.
1030 F. A. Fitton and T. Hall—Spindles and flyers employed in machinery for preparing and spinning cotton, &c.
1031 R. Neild, T. Smith and J. Yates—Looms for weaving
1032 J. Woods Signalling and giving alarm on railways
1033 W. Dennis—Construction of bottles
1034 W. P. Butchart—Treating and softening jute
1035 J. de la Coux des Roseaux — Lubricator for oiling axles, &c.
1036 T. H. Lucas—Fastening bales of merchandise
1037 G. Stuart—Taps aud valves used for regulating the flow of water, &c.
1038 W. Clark—Lamps
1039 W. W. Hughes—Propelling vessels
1040 C. E. Brooman—Producing oxygen
1041 J. Drew, B. Southwell, and H. White—Travelling bags
1042 W. Henderson—Oxidising minerals, &c.
1043 J. Barker—Spring centres for doors and other purposes
1044 W. R. Lake—Embalming dead bodies
1045 W. R. Lake—Combined water meter and force pump

Dated April 8th, 1867.

1046 H. A. Bonneville—A new kind of soap
1047 G. F. James—Covering woollen yarns with an outer yarn
1048 W. T Henley—Posts or supports
1049 W. T. Henley—Manufacture and treatment of wire
1050 W. E. Newton—Shells and other hollow projectiles
1051 W. Clark—Machine for cutting scale-board
1052 C. E. Brooman—Jacquard machinery
1053 G. Little—Regulating and transmitting electric currents
1054 C. F. Claus—Manufacture of chlorine

Dated April 9th, 1867.

1055 D. J. Fleetwood—Spoons, forks, &c.
1056 R. A. Rooney—Railways and trucks to be used thereon
1057 W. N. Wilson—Sewing machines
1058 J. L. Davies—Purifying smoke
1059 H. Forbes — Maintaining and augmenting motive power
1060 A. Morel—Winding up thread, &c.
1061 T. Redmayne—Construction of register or other open fire grates
1062 F. Waller—Spring for doors and other purposes

Dated April 10th, 1867.

1063 J. Ratcliffe and G. Wolstencroft—Looms for weaving
1064 J H. Player—Manufacture of phosphorus, &c.
1065 F. Lowe. T. Davy, and J. Metcalf—Pressing iron and appliance thereto
1066 J. R. Napier and W. J. M. Rankine—Valve seats
1067 J. H. Johnson—Hammers
1068 A. V Newton—Picking and ginning cotton
1069 W. R. Lake—Breech-loading firearms
1070 W. C. Cambridge—Fire bars, &c.

Dated April 11th, 1867.

1071 F G. Fleury—Measuring fluids
1072 A. C. Kirk—Blowing engines
1073 R. Day—Painter's easel
1074 R. Couchman—Buckles
1075 S. Smith—Breech loading sporting guns
1076 S. Barlow and T. Edmeston—Furnaces of boilers
1077 W. R. Lake—Multiplying power
1078 W. R. Lake—Manufacturing bricks
1079 J. Higgins and T. S. Whitworth—Preparing and spinning cotton, &c.
1080 W. Clark—Vermin traps
1081 G. Slater—Sewing machines
1082 T. A. Rochussen—Armour plating and sheathing of ships of war and fortifications
1083 J. J. Snow—Construction of locomotive figures and automata
1084 J. Dunbar—Exhibiting advertisements
1085 R. Courtenay—Propelling vessels

Dated April 12th, 1867.

1086 H. A. Bonneville—Metallic railway sleepers
1087 W. H. Dawes—Manufacture of iron
1088 W. Robertson and J. G. Orchar—Finishing textile fabrics
1089 H. P. Boyd—Manufacture of screws
1090 J. W. Wilson—Wrappers for covering woollen fabrics
1091 G. Wilmot—Accelerated teazing
1092 R. L. Hattersley and J. Smith— Looms for weaving
1093 C. H. Gardner and J. Bickerton—Printing machines
1094 H. B. de Beaumont—Ploughs
1095 T. H. Head—Rolling iron and steel
1096 W. Clark—Propelling vessels
1097 W. Clark—Obtaining isochronous movements applied to clocks, &c.

Dated April 13th, 1867.

1098 R. Shortrede—Improving the process for finding the deviation from the meridian on the common steering compass
1099 J. Aitken—Refining sugar
1100 K. H. Cornish—Breech-loading firearms
1101 E. Stevens—Sharpeners, &c.
1102 J. Shore- Natural self-tighting valve cock
1103 J. Jobson—Kitchen ranges
1104 C G. Gillyatt—Water drills
1105 W. Gregory—Grinding and polishing metal and other surfaces
1106 R. S. M. Vaughan and A. G. Harston—Window fastener
1107 C. Crockford—Obtaining useful products from certain materials produced in the process of galvanising iron with zinc
1108 C. Grace—Rudder pins and gudgeons
1109 R L. Hattersley—Looms for weaving
1110 J. Richardson and C. Greenwood—Coupling railway carriages and vehicles
1111 A. A. Langley—Railway brakes
1112 G. T. Bousfield—Manufacture of files
1113 R Alexander—Coatings to preserve the surfaces of metals, &c.
1114 S. Harrison—Watches
1115 W. Clark—Typographic printing machines
1116 W. Clark—Printing from engraved blocks, &c
1117 J. W. Cochran—Cartridges for breech-loading firearms
1118 Rev. J. Oakden and J. Pickin — Enamelling metals so as to prevent rust
1119 W. R. Lake—Shoes for horses and cattle

Dated April 15th, 1867.

1120 J. W. Breakell—Making windows in imitation of stained glass
1121 J. E Hodgkin- Oakum
1122 J. Hargreaves—Steel and soft iron
1123 G. Simpson—Working mining tools
1124 D Rankin—Oscillating steam engines
1125 E. B. Nunn and J P. Nunn—Separating substances according to their nature
1126 J. Lewthwaite—Knife-cleaning machines
1127 T. W Gray—Lightning conductors
1128 W. Wield—Winding yarns on bobbins
1129 E. C. Prentice and T. Richardson- Treating gun cotton
1130 R. Roby—Ploughs, etc.

Dated April 17th, 1867.

1131 S. Shore—Spinning and doubling fibrous materials
1132 J. S. Brooks—Colouring tobacco pipes
1133 A. Turner—Elastic cords or bands
1134 R. Roby—Screens for dressing corn, etc.
1135 J. W. Dalby and G. O. Chapman—Winding yarns
1136 A. N. Wornum- Pianofortes
1137 W. Cochrane—Breaking down coal stone
1138 T. Horsley—Breech-loading firearms

Dated April 18th, 1867.

1139 J Scott—Fire escapes
1140 W. Holding and J. Holding—Looms for weaving
1141 E. Wolf—Pipes for smoking
1142 W. Begg— Admitting and regulating the supply of air to furnaces
1143 E Lindner—Breech-loading firearms, etc.
1144 J. E. Mellin and C. H. Ulbricht—Boxes to contain address cards
1145 G. Ripley—Printing yarns
1146 W. Wilkinson—Catching fish

Dated April 20th, 1867.

1147 W. Kirrage—Bricks, etc., without the aid of artificial heat
1148 A. E. Griffiths—Pon for cooking omelettes
1149 J. McKechnie—Applying concentrated heat
1150 J. Millward—Brewers' mash tuns
1151 T V. Lee and C E Lankester—Manufacture of colours, etc.
1152 J. Galloway and T. Settle—Spindles, etc.
1153 W. Harrison- Consuming smoke in furnaces
1154 L. Davis—Hat guards
1155 J. Petrie and R. Ackroyd—Washing wool, etc.
1156 S. Cocker—Axles for carriages
1157 E. Howell and T. Hardy—Horse rakes
1158 R H. Frith—Distributing and measuring gas
1159 J. B Roby—Preparation of buffalo horn
1160 J. Atkinson—Construction of wheels
1161 W. G. Crossley—Velocipedes
1162 H. Fassmann—Metal ties and hands
1163 J. W. Cochran—Breech-loading firearms

Dated April 22nd, 1867.

1164 J. Peebles—Motive power engines
1165 C. De Tivoli—Breech-loading needle rifle and improved cartridge
1166 D. Fryer—Lamps
1167 J. Needham—Breech-losding fireorms
1168 W. E Gedge—Iron forks used in agriculture
1169 W. E Gedge—Trimming and zinking iron wire
1170 J. B. Mannix—Permanent way of railways
1171 C. T. Hook and E. Hook—Paper, etc.

Dated April 23rd, 1867.

1172 Rev. A. Rigg—Grinding grain, etc.
1173 J. Plews — Cartridges for firearms and ordnance
1174 E. Leigh—Bowls, etc.
1175 D. Whitaker and B. Crossdale — Looms for weaving
1176 J. Westwood—Turrets and broadsides of ships of war
1177 W. R. Lake—Feeder for centrifugal sugar machines
1178 W. R. Lake—Removing the contents from centrifugal sugar machines
1179 W. R. Lake—Diffusing liquids for refining sugar, etc.
1180 S. J. Mackie—Burning petroleum, etc.
1181 A. V. Newton—Blowing and pumping engines
1182 J. Brickles, J. S. Jackson, and W. S. Berry—Designs of fabrics composed of fibrous materials

Dated April 24th, 1867.

1183 J. Haworth—Portable apparatus for issuing tickets
1184 W. F. Wilkinson—Horse hoes
1185 J. Smalley—Mixing paint, etc.
1186 L. B. Bruen—Sewing machines
1187 T. Tivey—Narrow weavings
1188 C. F. Whately—Generating and distributing vapour
1189 J. D. Brickles—Woven fabrics
1190 J. H. Johnson—Treatment of peat, etc.
1191 T. South—Gas lighting and cooking apparatus
1192 W R. Lake—Checking and guiding horses
1193 F. Crossley—Cutting india rubber, etc., into slips

Dated April 25th, 1867.

1194 T. Lemielle—Ventilation of mines
1195 G. Gordon—Drying moist substances
1196 W. R. Lake—Knives, etc.
1197 S. L. Worth—Sweeping carpets, etc.
1198 C. E. Brooman—Destroying vegetable matters in wools, etc.
1199 C. E. Wetton and W. Galsworthy—Regulating the supply of liquids
1200 C. E. Brooman- Preserving meat, etc.
1201 J. Raywood—Commercial indicator
1202 A. M. Clark—Self-acting tackle hook
1203 J. Millward—Steam engines
1204 H. Smith —Preparing turnips and mangel wurzel for food for animals

Dated April 26th, 1867.

1205 E. G. Fitton and S. Deor—Looms for weaving
1206 C. D Abel—Pulverising substances
1207 J. W. Burton—Treatment of fibrous materials
1208 T. Booth—Keeping warm glues
1209 J. Archibald—Construction of tents
1210 J. H. Johnson—Magneto-lectric machines
1211 A. M. Clark—Lifeboats
1212 E. Guenin— Preparation and application of mustard for curative purposes
1213 W. Clark- Telegraph apparatus
1214 G. A. Huddart—Buttons, etc.
1215 W. E Newton—Burning wool, etc.
1216 L. B. Bruen—Shot cartridges
1217 G. Pollard — Reducing and regulating the quantity and pressure of steam fluids and gases

Dated April 27th, 1867.

1218 J. W. Cochran—Improved level
1219 J. Moseley and C. Moseley—Coverings for rollers
1220 D. Birkett—Fireproof floors
1221 J. Cariss—Locking, actuating, and setting in motion railway points and signals
1222 J. Dewar—Spray producer
1223 J. Speight—Spinning worsted
1224 J. W. Lowther—Lubricators
1225 T. Paton—Motive power engines
1226 W. Crocker and T. Wrightson—Raising and lowering weights
1227 J. Swinburne—Steam boiler furnaces
1228 J Taylor—Seats and sofas
1229 E. Guenin—Disinfection and treatment of fecal
1230 R. F. Chapman—Self acting signals for tunnels, etc.
1231 C. E. Brooman—Cartridges for breech loading arms

Dated April 29th, 1867.

1232 T. Watson—Warping threads
1233 J. F. Lawton—Producing a variation of colour during manufacture upon yarns
1234 G. Davies- Packing for stuffing boxes
1235 J. Birn—Buckets for air and other pumps
1236 E. T. Hughes—Improvements in bobbins
1237 P. J. J. Allibert—Preventing incrustation in steam boilers
1238 J. H. Johnson—Preventing the access of insects to the interior of dwellings, etc.
1239 M. A. F. Mennons—Alarm apparatus
1240 E. Waterman—Boots and shoes
1241 J. Combe—Winding fibrous substances
1242 R. Smith and M. B. Westhead—Making up tapes
1243 T. Bell and T. L. C. G. Bell—Manures

Dated April 30th, 1867.

1244 G. Severn—Rails for tramways
1245 G. Davies—Cutting and dressing millstones
1246 R. Booth and R. W. Booth—Fret sawing machines
1247 H. P. Swift—Marine screw propeller
1248 R. W. Ridley and J. Withers—Indicating measure tops
1249 E. Deeley—Rolling hoop iron
1250 G. Davies—Taper holder and match box
1251 T. Webb—Sewing machines
1252 G. Hodgson—Power looms
1253 J. Marshall—Gun barrels and ordnance
1254 A. M. Clark—Sugar
1255 C. De Grelle—Breech-losding firearms

Dated May 1st, 1867.

1256 W. Snell—Boots and shoes, etc.
1257 A. Louet—Movable palisades
1258 W. E. Gedge—Mattresses, etc.
1259 J. J. Krafftert—Self acting repeating rifle
1260 R. Young—Cases and boxes for holding needles, pins, etc.
1261 F. Jossa—Lubricators for the supply of mineral and other oils to bearings and journals of shafts
1262 H. A. Clum—Instruments for indicating atmospheric changes and the force of storms
1263 J. Howell—Hay and chaff cutting machines
1264 J. H. Johnson — Novel flux applicable to welding, etc.
1265 J. H. Johnson—Boots and shoes
1266 J. H. Johnson—Boots and shoes
1267 J L Norton—Drying machines
1268 S. Newington—Buildings and structures to be employed for horticultural purposes
1269 E. B. Bigelow—Looms for weaving
1270 J. Thomlinson—Fire proof and other ceilings and floors

Dated May 2nd, 1867.

1271 J. Brown—Construction of fortifications
1272 P. Salmon—Making and holding of gas for illuminating, etc.
1273 J. Lomax and J. Lomax—Wagons for collieries
1274 H. A. Bonneville—Ribbon looms
1275 H A. Bonneville—Transmitting the hour and the synchronism of the hours by electricity between public and private clocks
1276 H. A. Bonneville—Learning how to write
1277 A. Brunier—Hat cover
1278 C. H. Collette—Flights of stairs
1279 C. D. Abel - Administrative telegraphy
1280 J. Smyth and S. Kirby—Clarinets
1281 F. Walton—Infusion of coffee
1282 C. Dutton—Screening coal
1283 G. A. J. Schott and J S. Rosenthal—Species of yarn
1284 T. Wood—Safety valves
1285 J. H. Johnson—Locomotive and traction engines
1286 J. Stuart and J. H. Smith—Combination of mechanism for operating certain parts of sewing machines
1287 W. R. Lake—Nutmeg grater
1288 J. F. Collins—Alcohol and other spirits
1289 C. Ritchie—Storing and drawing off beer

Dated May 3rd, 1867.

1290 C. Cherron—Figure weaving machinery

OTIVE,

FIG. 3.

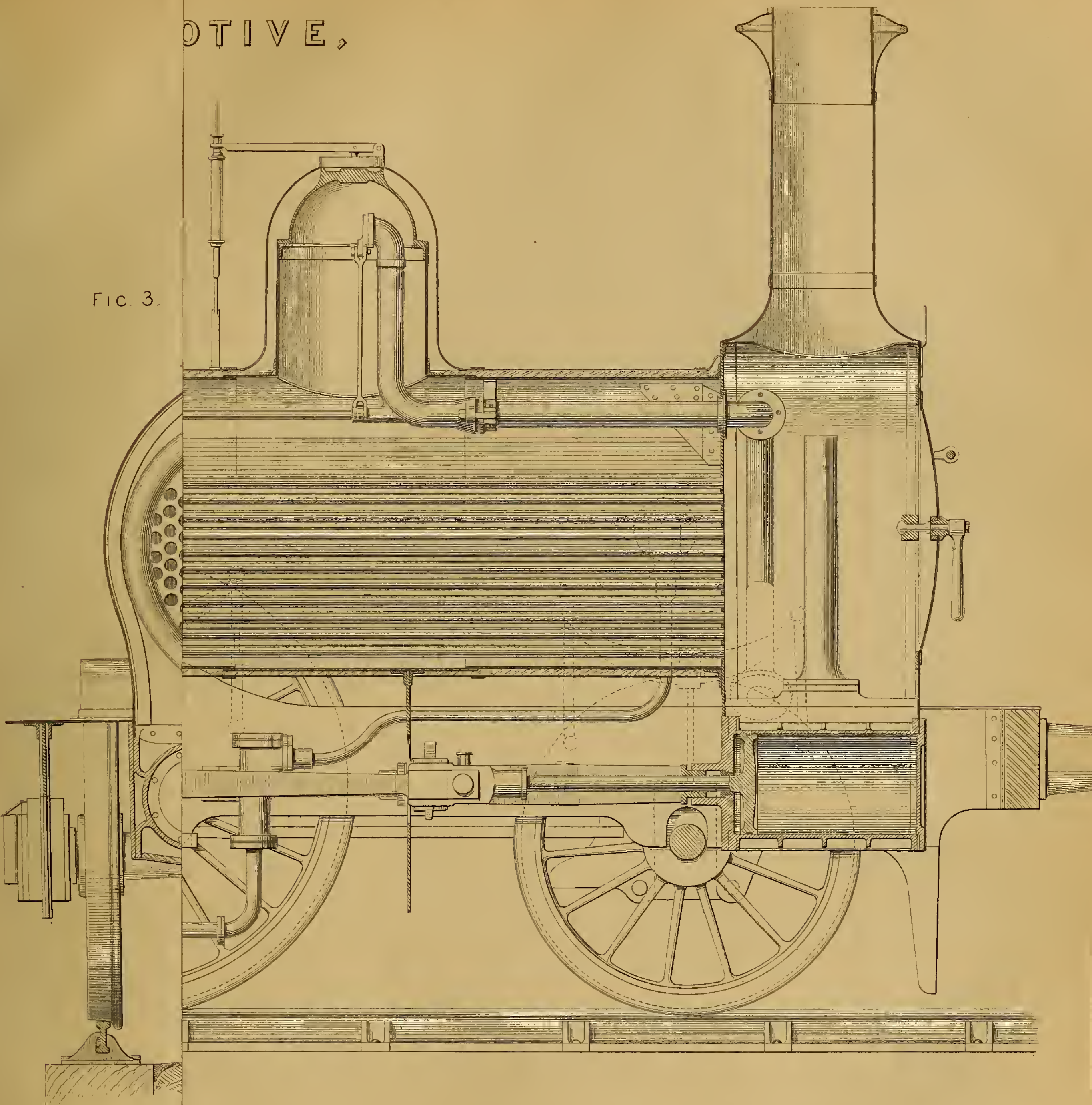
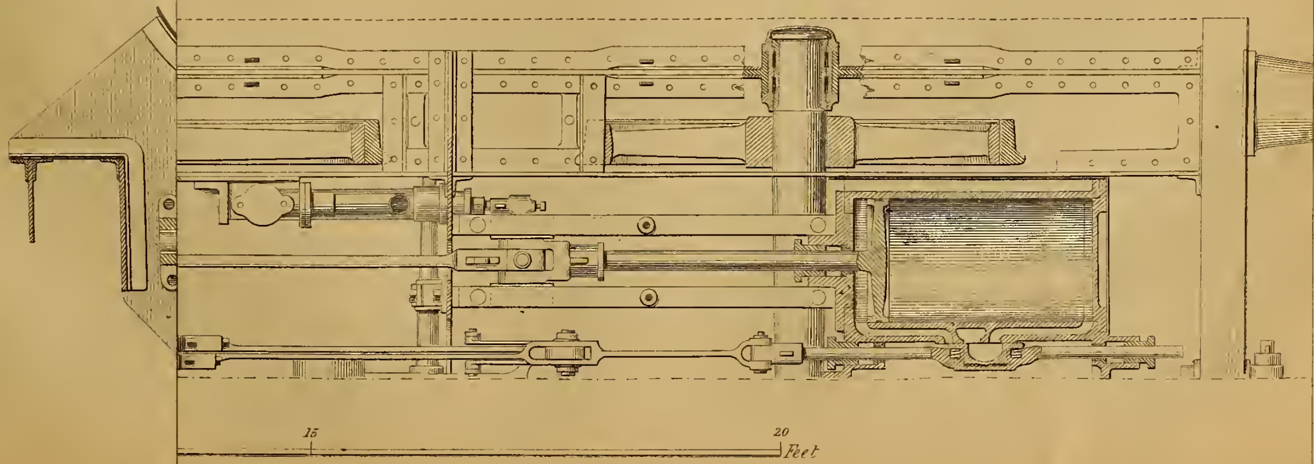


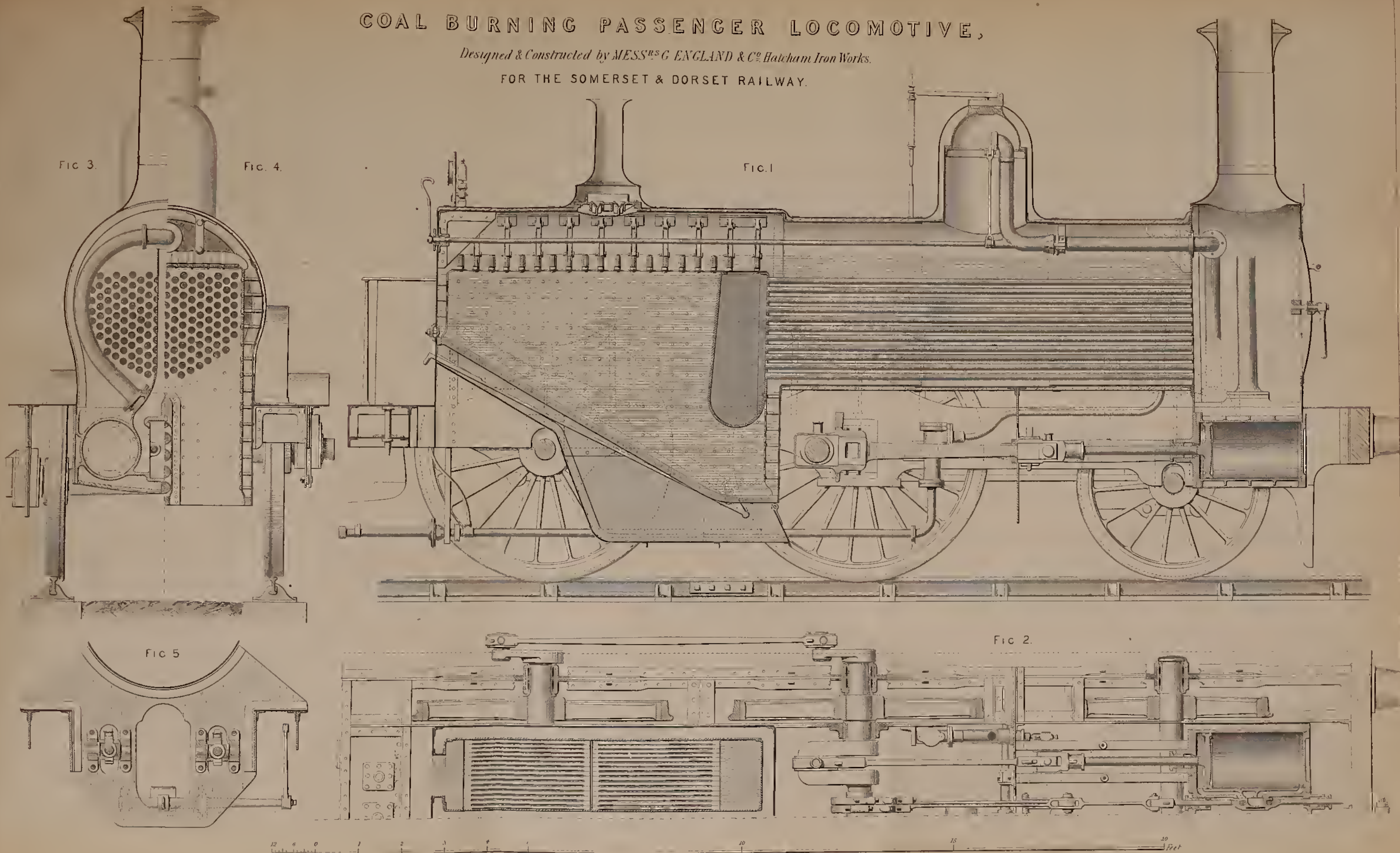
FIG. 2.



COAL BURNING PASSENGER LOCOMOTIVE,

Designed & Constructed by MESSRS G. ENGLAND & Co. Hatcham Iron Works.

FOR THE SOMERSET & DORSET RAILWAY.



THE ARTIZAN.

No. 7.—Vol. I.—Fourth Series.—Vol. XXV. From the Commencement.

1st. JULY, 1867.

THE INTERNATIONAL EXHIBITION OF 1867.

Machinery at the Paris Exhibition.

Mr. Thomas Holt, engineer of Trieste, exhibits in the Austrian department drawings and models of his steam boiler.

The invention consists in replacing the tubes in ordinary boilers by a series of discs formed of plates, rivetted or welded at the ends, through which the heated gases pass in the same manner as through the tubes. It is stated that by this means an immense increase of heating surface is obtained as compared with boilers of equal size constructed on the ordinary system, directly over and near the fire; for example, a stationary boiler, 20ft. in length, on the ordinary system, would have 470 sq. ft. heating surface; whilst one constructed with discs on Mr. Holt's plan would have 5,000 sq. ft. A more perfect combustion of the fuel and gases is obtained in this manner, evaporating about 40 per cent. more water with the same amount of fuel than by those at present in use.

On this principle great strength is combined with durability, the discs serving as stays. From the form of the disc, giving great strength, the plates can be made much lighter (for equal pressures) than those of the present construction. This invention can be applied to the generality of boilers at present in use, and it is equally adapted for stationary, portable, locomotive, and marine boilers.

In the locomotive boiler a series of discs are placed over the fire box, super-heating the steam; and the upper part of the discs in the upright boiler serves for the same purpose.

The discs by their elasticity have another great advantage, that of self-cleaning, and not allowing any hard incrustation to be deposited upon them; they are also not so liable to leak as tubes, as they are rivetted to the end plates.

These boilers occupy less space, and a saving of from 30 to 40 per cent. in fuel is effected: evaporating with slow combustion a cubic foot of water with 5lbs. of coal, in place of 9lbs. and even more, consumed by boilers of the present construction.

The following is the result of experiments that have lately been made before a commission appointed by the Imperial Austrian Marine at Trieste:—

Date.	Length of Trial.	Consumption of Fuel.	Fuel used.	Quantity of water evaporated.	Temperature of feed water.	Height of water in boiler.	Pressure.	Results.
1867.	h. m.	lbs.		cub. ft.	Fahr.	ins.	lbs.	
21 April	15 0	802·75	Cardiff	163·25	122°	6·22	18·52	1·115 c. ft. water evaporated by 5·43lbs. of coal.
27 April	9 35	307·50	Cardiff	70·27	66°	6·22	18·52	1·115 c. ft. water evaporated by 5·88lbs. of coal.

We believe that Mr. Holt applies this system of construction to surface condensers.

In the annexe of Class 47, near the Porte de l'Université, Mr. F. Girard, of Paris, exhibits some improvements in the manufacture of tin plates. In the ordinary process the iron plates, after being pickled and annealed, are dipped in melted grease; they are then plunged into a bath of melted tin which is covered with melted grease; the surface being imperfectly covered with tin. The plates are plunged into another bath of melted tin and left a sufficient time to make the alloy complete; they are then wiped on both sides with a hempen brush, and to remove the marks of the brush and to give a polish to the surface they are dipped again in a bath of melted tin, and finally dipped in a grease pot at a high temperature to remove any superfluous tin.

By Mr. Girard's apparatus a uniform surface of tin is obtained by one dipping only, and the baths of melted grease and process of brushing are dispensed with altogether. The machine for turning iron plates, as shown at work in Class 47, consists of a cast-iron bath divided into two compartments A and B, containing the melted tin, and communicating with each other by a small passage C. The furnace F, for melting the metal, is placed underneath the compartment A, and the heat in the compartment B is regulated by allowing the heated gases to pass either in the flue F or G; this is done by means of dampers. In the compartment B, the melted metal is always at a lower temperature than in the other, and in this are placed a pair of revolving turned cast iron rollers about 8in. in diameter; the level of the melted tin is kept a little above their point of contact. These rollers can be regulated as required, so as to allow the iron plates of various thicknesses to be passed between them, and to give them any required coat of tin. The iron plates are plunged into the bath by the workman on the guide H, they are taken between the rollers and come out on the other side coated with tin on the guide K. A little resin is thrown on the rollers as a flux. Iron plates are tinned in this manner at the rate of from 10 to 20ft. per minute. The unhealthy vapours produced in the bath are carried away up the chimney by the funnel-shape covering M.

In the Wurtemberg Annexe, near the Ecole Militaire, Messrs. Decker, Brothers and Co., of Cannstadt, exhibit a machine for the manufacture of wood pulp for paper making. This machinery, the invention of M. Henry Völter, is set in motion by three portable engines of together 50-horse power, constructed by Mr. Colla of Paris. Upwards of eighty of these machines are at work in various parts of Europe. A clean white pulp suitable for paper making, is produced at about half the cost of rags on this machine, and it is said that, owing to the increased use of wood pulp, a rise in the price of rags has not taken place. In Germany there is hardly a newspaper printed, the paper of which does not contain more or less of wood pulp. Papers for printing purposes contain from 50 to 80 per cent. of wood pulp; writing paper from 30 to 50 per cent.; and some cardboard is exhibited made entirely from wood pulp. For printing purposes, paper containing a certain per cent. of wood pulp is preferred to that made entirely of rags.

The machine shown by Messrs. Decker consists of an ordinary grindstone about 4ft. in diameter and 16in. in width, revolving in a casing of cast iron, divided into five rectangular chambers about 8in. in depth, in which the pieces of wood to be reduced to fibre are placed, whilst water is constantly running over it. The wood is pressed down against the grindstone by means of pistons working in the chambers, these pistons are advanced by means of a self-acting mechanism. 12 to 14 cwt. of wood pulp are produced in 24 hours by this machine, which requires only two men to work it. The fibres and water pass from the "defibrer" or grindstone to the coarse sorting apparatus, which consists of a drum covered with coarse wire netting revolving in a tank, the pulp passes through the meshes to the centre of this drum and is passed off to another tank; the coarse splinters of wood which constitute the waste (though only in a small quantity) remain in the tank and are cleared away by a revolving rake.

In the second tank there is another wire-covered revolving cylinder which separates the coarse part of the fibres and conducts them to the refiner, whilst the finer passes through and is collected for the coarser quality (No. 3) of pulp.

The refiner consists chiefly in a pair of millstones in which the pulp is refined and purified, and the fibres are made more pliable. It then passes to the sorting apparatus consisting of wire-covered cylinders which sort the pulp according to the degree of fineness of fibre, and delivers the different qualities into boxes.

In the last for pulp No. 1, the water is extracted by means of a revolving cylinder covered with wire gauze of 40,000 holes to the square inch.

Pine is preferred on account of its superior length of fibre, but where perfect whiteness of pulp is required, aspen or lime is used.

SPINNING MACHINERY AT THE PARIS EXHIBITION.

The machinery for the preparation and spinning of textile materials occupies a most important place in the Paris Exhibition, and the principal makers seem to be well represented.

In the French Department perhaps the most complete displays of cotton machinery are those of Messrs. Schlumberger and Co., of Guebwiller (Haut Rhin), and of Messrs. Stehelin and Co., of Bitschwiller (Haut Rhin). That of the former consists principally of machinery for combing and carding. A double carding machine (the first or breaker cylinder is furnished with four pairs of workers, and the finisher with automatic stripper for "top flats,") on Willman's system, is worthy of attention. The cotton is opened and cleaned by the working rollers before reaching the flats. The flats are lifted out of their places one at a time, for the purpose of stripping without being turned over, and a wire brush is drawn across the face of the flat to remove the dust and fly, the flat being gently pressed down on the brush during the action of stripping. The stripping operation is effected by a cam motion; it is particularly ingenious and simple, and imitates stripping by hand.

The combing machine is the invention of Mr. Heilmann, of Mulhouse, and is specially adapted for combing long staple for fine numbers. The lap is placed upon two revolving wooden rollers at the top of the machine, which cause it to unwind and deliver the sheet down an inclined guide to a fluted steel feeding roller, which places the cotton between the open jaws of a pair of iron nippers. The nippers are then closed, and by a cam motion are made to approach the revolving comb cylinder, and the cotton is held by it till all the short fibres and impurities are combed out. The combs are cleaned at every revolution by means of a cylindrical brush. As soon as the combs have passed through the cotton, the nippers recede from the cylinder, and open, to allow the partly combed fibres to be drawn out from the lap by means of a leather-covered roller working for this purpose in contact with the fluted segment on the comb cylinder, and with fluted detaching rollers. The drawing-out of these fibres causes the ends which were before held by the nippers to pass between the teeth of a fine top comb, and prevents any waste being drawn forward. The machine is so arranged that the tuft of cotton is deposited on the detaching roller in such a manner as to overlap the ends of the others, and form a continuous sliver, which is deposited in a can revolving slowly on one side of the machine, whilst the waste is coiled in a can on the other side. Messrs. Schlumberger and Co. also exhibit roving and drawing frames, and a self-acting mule of excellent construction.

Messrs. Stehelin and Co. show machinery for the process of double carding, consisting of a breaker carding machine with working and clearing rollers, a lap doubler, and a "finisher card," mounted with eighteen self-stripping flats, on Willman's system. They also exhibit a self-acting mule of 442 spindles of good workmanship, with four pairs of drawing rollers. The back of the carriage forms a parabolic curve in plan; by this arrangement increased steadiness is secured.

A "finisher" carding-machine is exhibited by Messrs. Vallery and Delarocque, of Rouen, fitted with Mr. Dannery's automatic self-stripping flats, which is somewhat on Willman's principle.

The most complete series of machinery for preparing wool in the French department is that of Mr. Mercier, of Louviers (Eure), and consists of:—

1. A burring and opening machine. This machine is self-feeding; the wool is thrown into a box the bottom of which is an endless lattice, which works towards a a perpendicular endless lattice, furnished with hook-shaped teeth, which lift the wool within range of a taker in roller covered with steel spikes, and in this manner a nearly uniform supply of wool is presented to the first revolving beater with four blades. The second revolving cylinder is provided with four rows of strong teeth, which strike the wool and pass it over to a hollow cast-iron cylinder 22in. in diameter, covered with 54 rows of combs. Between each comb-blade there is a longitudinal slit in the cylinder ⅜in. in diameter, which tends always to keep the combs free from dirt. The burrs pass away through a grate, and the wool is taken from the combs by a revolving brush.

2. A set of three carding machines having 44in. cylinders, with five workers and five strippers, about one-fourth the diameter of the workers. The wool is delivered to the "scribber" or breaker carding machine by means of a self-feeding and burring apparatus similar to that previously described. The wool is stripped off from the doffer and the fleece is formed into a sliver, which falls upon an endless travelling cloth which conveys it to the intermediate card. The sliver is then formed into a fleece by means of "Apperley's feeder," which lays it diagonally across the travelling lattice, doubling it backwards and forwards from side to side. This card also forms a continuous sliver which is passed on an endless travelling cloth to the "condenser," likewise provided with Apperley's diagonal feeding apparatus. The wool is stripped from the doffer cylinder by means of two stripping rollers, consisting of alternate stripping rings and blanks. The top roller takes off 25 alternate strips of wool and a waster from the doffer, and the 25 remaining strips are taken off with a waster at one side by the bottom roller; these strips are drawn into yarn by being rubbed in passing between two endless bands of leather, with an alternate movement across the strips.

3. A double carding machine with self-feeding apparatus and burring cylinder for the preparation of long wool. The wool is formed into a continuous sliver and wound into balls for the supply of the circular combing machine. This machine, which is of highly ingenious construction, is capable of combing from 275 to 330lbs. of fine Merino, and from 440 to 550lbs. of ordinary wool per day of twelve hours. It consists of a circular horizontal comb about 4ft. in diameter, making 3½ revolutions per minute; the slivers of wool, being 72 in number, are placed below on bobbins, and the ends pass through separate holes in the framing to corresponding troughs or guides. These troughs are raised by a cam motion in such a manner that the ends of the slivers are raised over the revolving comb in two places, one opposite the other, at these points. A brush, making 600 strokes per minute, descends and places the tuft of wool upon the comb and upon two smaller revolving combs placed tangentially at those points. In this manner the teeth of the combs are filled with wool, and in revolving the ends are guided by endless leather bands between fluted rollers, which draw the tufts through the combs, and the four slivers thus formed, pass to the top of the machine, and are formed into one by passing through rollers, and wound upon a bobbin. The short wool and waste remaining between the teeth are cleared away in four places by triangular plates or clearers, and are passed away to a can underneath the machine.

4. Two self-acting mules, one with 400 spindles and the other with 450 spindles. The "double speed" or fast and slow motion is applied with two pulleys, the change being obtained by a traverse of the straps and two runs without the aid of gearing, the rim out of action in either case being converted into a carrier pulley.

Mr. Vouillon, of Louviers, shows a machine constructed by Mr. Mercier, for the production of *fils feutrés*, or threads felted by a rubbing process instead of being spun. Thirty slivers from the condenser are wound upon a wooden roller placed at one end of the machine. These slivers are drawn into yarn by being passed on an endless band of felt, covered with linen, under four rollers covered in the same manner; these rollers have an alternate motion across the threads which are wound at the other end of the machine. A steam pipe is introduced between the first and second rollers, for the purpose of heating the wool to facilitate the operation of straightening the fibres.

Some improved spinning machinery is exhibited by Mr. Vimont of Vire, and consists of a continuous spinning frame with 100 spindles. The rovings wound on a roller are placed at the top of the machine, and are conducted between a pair of rollers to an eye through which they pass, making 3,000 revolutions per minute. The thread then passes through a small eye in a piece of wire attached to the revolving eye, and in this manner the wool is spun. The requisite tension is given to the thread by passing over two rollers made of tin of triangular shape. The thread, after leaving the revolving eye, passes between a pair of rollers to the spindles. The coping motion is produced by a rack and pinion by which a rail carrying a guide for the thread, working independently of the spindle rail, is caused to traverse the thread on the spindle. The conical ends of the cops are formed by the irregular rising and falling of the rail carrying the spindles, which is produced by a cam motion; the winding as well as the twisting is continuous, and the cops wound by this machine are wound extremely hard.

Messrs. Pierrard-Parpaite, of Reims, show some highly important machinery for cleaning and dressing wool, consisting of burring, opening and carding machines, and machinery for freeing the fleece from oil. A continuous spinning-frame is also exhibited by this firm, the principal peculiarity of which consists in the driving of the spindles and flyers quite independently of each other, and at different speeds. Each spindle can be thrown out of gear by a simple arrangement, without stopping the machine. The bobbins filled with rovings are placed on a creel at the top of the machine. The rovings pass through the usual drawing rollers towards the spindle; the flyer is formed with arms of equal length, with a spiral groove cut out in each of them, and mounted on a tube through which the thread passes, and is led towards the spindle, and protected from the centrifugal force occasioned by its large speed.

Messrs. Stehelin and Co., besides some wool-carding machines, which are not shown at work, exhibit a novel circular wool-combing machine. The slivers wound upon bobbins are placed on a creel and their ends passed between a pair of fluted rollers. The wool is then taken by an endless comb formed, in an ingenious manner, of a series of bars with teeth which are supported and advanced by two screws. When each bar in turn has reached the end of its course, it drops down upon another screw revolving in a contrary direction, and is brought back and raised by a cam into its former place. The wool is taken next by a pair of nippers from the comb; from the nippers it is taken by another comb at the end of a radius rod which then places the tuft directly over the circular horizontal

comb, on which it is placed by a descending brush, after making about one quarter revolution. The ends of the wool are conducted by an endless leather strap and drawn by a pair of fluted rollers through a hollow revolving cone through which the wool passes to the coiling can. The combs are cleaned by triangular clearers, and the waste passed off to another can on the opposite side of the machine. The produce of this machine is 200 to 600lbs. of wool per day.

Another equally ingenious and perhaps more simple circular combing machine is shown by Messrs. Morel & Co., of Roubaix (Nord). In this machine the wool is fed in from each side, so that a description of one feeding apparatus will be sufficient. The machine consists principally in a revolving comb about 4ft. in diameter. The ends of the 15 slivers wound upon bobbins fixed on a creel are brought forward by an arrangement of combs over the inside of the circular comb, where they are seized by a pair of pincers and placed upon the teeth by a descending brush; the ends of the tufts of wool on the comb, after making about a quarter turn, are drawn by endless bands of leather and pass between fluted rollers to a coiling can. The waste is cleaned from between the teeth by triangular clearers and passed to another can. The production is about 700lbs. per day of twelve hours. The combs are fixed on the top of a revolving cylinder, inside of which projections are cast, forming cam motions for giving movement to the nippers or seizers, the placing brush, etc.

(*To be continued.*)

VANDENKERCHOVE'S SINGLE AND DOUBLE CYLINDER STEAM ENGINES.

(*Belgian Section, Class* 53, *No.* 40.)

Mr. Prosper Vandenkerchove, engineer, of Ghent, exhibits in this section two horizontal steam engines, one of which is constructed upon the Woolf double-cylinder plan, with certain modifications; whilst the other is a one-cylinder engine, with separate slide valve and exhaust arrangements.

1.—Double-cylinder Engine.

In this engine the principle of working the pistons of the two cylinders in opposite directions (*à marche inverse*), *i.e.*, so that the piston of one cylinder is at the top of its stroke, whilst that of the other is at its bottom, has been applied. Our readers will remember that the same principle was successfully carried out by Messrs. Randolph, Elder, and Co., of Glasgow, to the engines of the *Callao*, *Lima*, and *Bogota*,* but in all these the cylinders are vertical, or, to speak more correctly, they lie diagonally to each other. At the "Regional" Exhibition of Rouen, in 1859, a 16-horse power horizontal engine, constructed on the same plan, by Messrs. Boudier Frères, was at work, in which the two cylinders and their jackets were cast in one piece; a similar engine has been exhibited by Messrs. Boudier at Paris this year. Mr. Vandenkerchove's engine is also horizontal, but of a much larger size, and, besides, it has a peculiar slide-valve arrangement shown in our illustrations. The chief dimensions, &c., of this engine are:—Diameter of large cylinder, 24in.; diameter of small ditto, 12in.; length of stroke for both cylinders, 4ft.; length of connecting rods, 9ft. 6in.; diameter of fly-wheel, 16ft. It is designed to work at a pressure of 45lbs. per square inch, and a cut-off at ths of the stroke. Under these conditions, and with 36 revolutions per minute, it will yield 110 indicated horse-power.

In our illustrations, Fig. 1 (see next page) shows a sectional plan of the cylinders; Fig. 2 a cross section of the same through α — β at the bottom, and Fig. 3 a cross section through γ — δ in the middle of the cylinders. The scale of these engravings is ½in. to the foot.

The chief feature in which Vandenkerchove's arrangement varies from Randolph and Elder's are:—

1. The greater proximity of the two cylinders to each other, which is attained by interposing only a plate, instead of a D valve between both—a system for which the Belgian firm took out a patent some years ago.

2. There is a more rapid communication between the two cylinders, the intermediate slide-valve having two apertures instead of one, and both valves being actuated by twisted cams, instead of eccentrics.

3. The travel of the slide-valve is shorter than in Randolph and Elder's arrangement, and by this means the size of the valve-box and the clearance are reduced to smaller proportions.

Fig: 2.

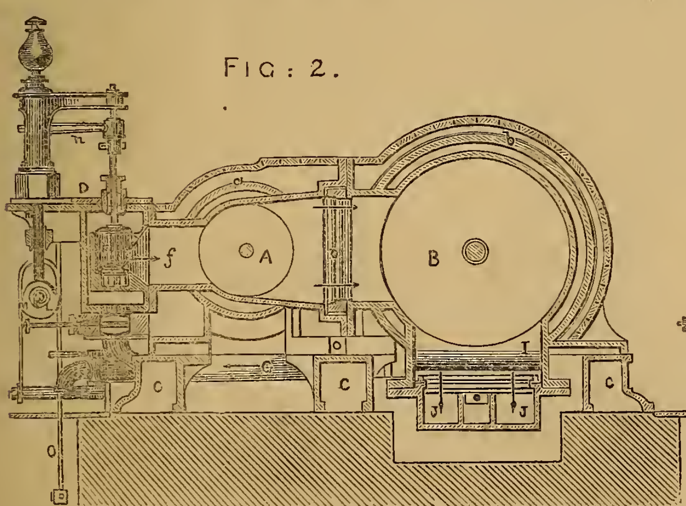
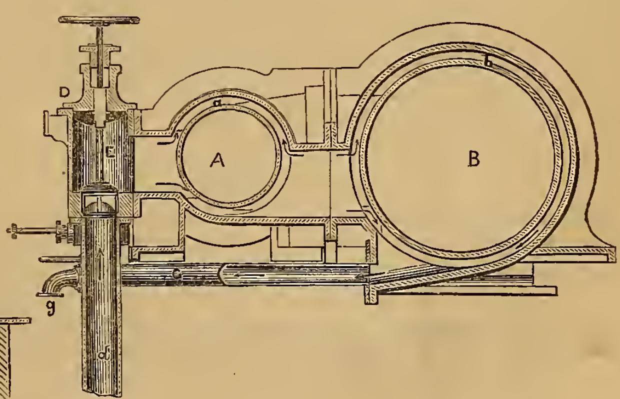


Fig: 3.



The letters of reference in all the three figures denote:—

A B high pressure and low pressure cylinder.

A[1] B[1] High and low pressure piston.

C C frame upon which the engine is fitted.

D valve-box containing the valves E and G G.

E sluice-valve, by means of which steam is admitted into the spaces between the cylinders A B and their jackets *a b*.

F F equilibrated expansion valves, admitting the steam into the high-pressure cylinder on its emerging from the jackets, and cutting it off at will.

f f ports through which the steam enters the cylinder A.

G condensed-water pipe, and

g condensed-water cock.

H H slide-valve between the two cylinders.

h h ports leading from the high pressure to the low pressure cylinder.

I exhaust.

J exhaust-pipe leading to condenser.

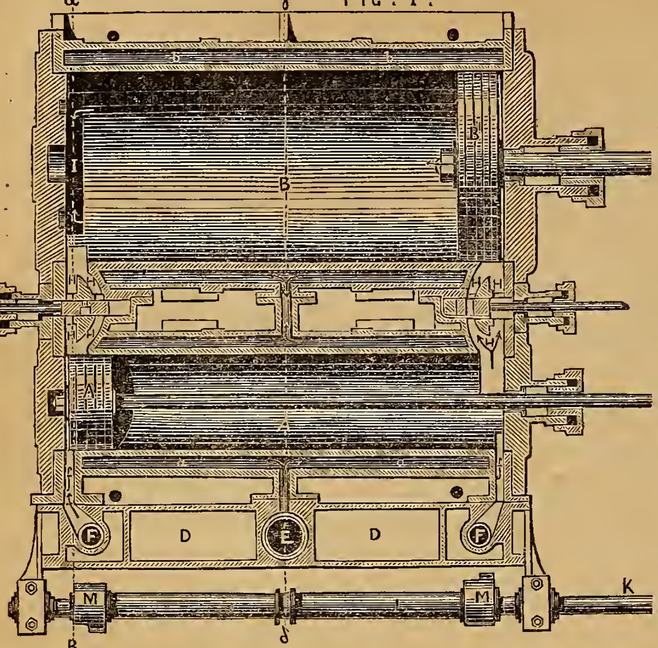
K shaft fitted with hollow shaft L and cams M, actuating the expansion valves F F by means of the spindle *m* and the lever *n*.

N lever for regulating the cut-off, actuated by the governor or by hand.

The mode in which the double-cylinder principle has been carried out in this engine (though somewhat complicated, and rather delicate) as

* See The Artizan for October 1, 1859, p. 254, and Aug. 1, 1860, p. 217, and plate 175

FIG: 1.



well as its general arrangement, reflect high credit on the makers; some details of the construction, however, are, in our opinion, open to objection. The economic working of an engine is decidedly of the highest importance, even in countries where the price of fuel is very low; nevertheless, the first cost should not be disregarded, and costly arrangements in the individual parts, more especially such as would in no way tend to reduce the consumption of fuel, should be avoided. Now, Mr. Vandenkerchove's fly-wheel, having 16ft. in diameter, consists of as many as thirty-three pieces, and the eight arms are each separately fitted to the crown and into the boss. Such and similar arrangements are not admissible in a country in which the price of labour ranges far higher than that of the raw material. Similar strictures might be made on several other parts of the engine. For the remainder, however, we may say that the principle itself upon which it was constructed, is perfectly sound, and to judge from indicator diagrams we have before us, the results obtained appear very favourable.

2.—SINGLE-CYLINDER ENGINE.

In its general appearance and in the details of the construction this engine varies but little from the double-cylinder one just described. Its chief dimensions are :—Diameter of cylinder, 30in.; stroke of piston, 5ft.; length of connecting-rod, 12ft.; diameter of fly-wheel, 18ft. It is designed to work at a pressure of 45lb., and the steam may be cut off at one-fifth of the stroke. The indicated power, "guaranteed by contract," is 180 horse. In this engine the slide-valve arrangement is similar to that of the double-cylinder engine shown in Figs. 1 to 3. Its working, also, appears satisfactory enough; but some of the details of the construction are open to improvement, and we have a very decided objection to the aspect of the fly-wheel. We may observe that in both these engines the toothed gearing is fitted to the crown of the fly-wheel, and consists of sixteen separate pieces.

We are given to understand that a pair of Mr. P. Vandenkerchove's engines are at present at work at Messrs. Morel and Verbeke's cotton mill, Ghent, and that they give general satisfaction. From some further particulars which the same makers have kindly furnished us we gather that, upon an experiment made some time ago, an indicated power of 222 horse was obtained from an engine of the one-cylinder class exhibited at Paris, with the steam cut off at one-sixth of the stroke, and an initial pressure of 55lbs. and mean pressure of 32lbs. per square inch.

STILMANT'S RAILWAY BRAKE.

(*French Department, Class* 63, *No.* 45.)

The Eastern Railway Company of France exhibit, among various other articles, a goods truck, built at the Company's Works, in La Villette, and furnished with Stilmant's brake, called *frein à entraînement.* This brake is now in very general use in the carriages and trucks of that company, as well as those of the Northern and Western Railways of France. The brake-blocks are made of cast-iron, and are suspended to the carriage frame by means of links having oval holes for the suspending pins, so as to permit a certain amount of vertical movement. They are connected by adjustable rods to a pair of inclined slides. Between these works a wedge, formed of two parts jointed together, which readily accommodates itself to the varying inclination of the slides as the latter open, and, being connected to these by dovetails, it draws them together when raised, or forces them apart when depressed. A link connects the wedge to a short lever fixed on a rocking shaft, which is carried by bearings fixed to the carriage frame. Upon the same rocking shaft a long lever is placed, by which the power of the brakesman is applied either directly, or by means of a screw and hand-wheel. By the arrangement and proportioning of the various parts of this brake the skidding of the wheels to which it is applied, is effectually prevented.

FIRE ENGINES AT THE PARIS EXHIBITION.

STEAM FIRE ENGINES.

Of these there are specimens by three makers, viz., Messrs. Mazeline, of Havre; Merryweather & Sons, of London; and Shand, Mason and Co., of London,

HAND-WORKED FIRE ENGINES.

Their numbers are legion and range from the small engines of Constantinople, carried on men's shoulders, and those from nearly every country in Europe, to the London Brigade engine, drawn by a pair of horses and carrying the firemen with all their implements upon it.

DESCRIPTION OF STEAM FIRE ENGINES.

The engines exhibited by Messrs. Mazeline (Class 53, No. 147) is upon the system of Lee and Larnard, of New York, and is similar to one made by Easton and Amos, of London, for the Crystal Palace Competition in 1863. The double cylinders are horizontal and worked at a short stroke, but without circular motion.

The engines by Merryweather and Sons (Class 53, No. 26), are similar to those exhibited by them in London in 1863, being horizontal, both with single and double cylinders, and like Lee and Larnard's, without circular motion, but worked at a long stroke.

Of the engines exhibited by Shand, Mason and Co., (Class 53, No. 36), one is a vertical engine with single cylinder, as exhibited by them in London in 1863; and the other a horizontal one with double cylinders on the bucket and plunger principle, the first engine of the kind yet constructed.

TRIALS.

The jury inspection of the fire engines having been accomplished on April 17th, the first trial took place on the 23rd of April. The small engines, one each by Shand, Mason and Co. and Merryweather and Sons, were simultaneously worked from the Seine; the hose from each being conducted to the iron light-house; 320ft. were attached to the engine of Merryweather and Sons, and by some oversight one additional length, of 36ft. to that of Shand, Mason and Co. The engine of the former was got to work in the shortest time, but a slightly greater height was attained by the jet of the latter as shewn against the lighthouse; the diameter of the jet of each engine being one inch.

Next came the turn of the large engines, one by each of the three makers. Messrs. Merryweather and Son declining to work their engine at this trial, as it had only that morning arrived at the Exhibition from London, the two others alone were tried, being worked from the Seine. The result of the various trials was that Shand, Mason and Co.'s engine threw two jets each 1½in. diameter, at the same time, higher and farther than the Havre engine, which threw one of a smaller size.

The second trial took place on the following day, the 24th April, when Messrs. Merryweather and Sons' large engine worked from the lighthouse lake through one 40ft. length of hose. Steam was got up slowly without regard to time, and a jet 1¾in. diameter was frequently thrown to a little above the projecting gallery of the lighthouse. Messrs. Shand, Mason and Co. not having had time to complete the experiments with their large engine, and also to get into the Exhibition before the 10th March, asked for a few days delay before working alongside the lighthouse; the jury at once acceded to this request.

The third trial could not, on account of the demands upon the time of the jury, be arranged for an earlier date than the 18th May. On the morning of that day Shand, Mason and Co.'s large engine was placed in position by the lighthouse lake, but the officers of the Imperial Com-

mission immediately interfered and would, on no account, allow the engine to be worked there, as they stated that upon the former occasion great damage had been done to the grounds, etc. The only alternative left was to take the engine to the British Annexe by the Seine and work it there, projecting the water across the river.

The boiler fire was laid with ordinary wood and shavings, no inflammable material being used. A light was applied about a quarter before three o'clock and in 11 minutes and 20 seconds 100lbs. steam pressure was obtained. The engine was then started drawing instantly; the vertical depth being 22ft. from the level on which the engine was placed, to the surface of the water in the Seine. With the 2in. jet 120lb. water pressure was reached and the great height attained astonished all. The members of the jury expressed themselves much pleased with the power and steadiness of the engine, and particularly noticed the excellent steaming power of the boiler, the furnace door being open about half the time. The 2in. jet was occasionally changed for one 2¼in. diameter, but the engines worked continuously during the experiments, which lasted between one and two hours.

RAILWAY ENGINEERING AND MANAGEMENT IN FRANCE.

The official catalogue of the Paris Exhibition contains, at the head of each class, an *exposé* of the past and present state, and the future prospects of each of the French industries the products of which are comprised in the class noticed. Most of these papers were written by prominent members of the Imperial Commission, and a selection of some of them, which we give in translation, will doubtless be welcome to most of our readers.

The following paper, prefixed to the list of articles exhibited in Class 63 (railway plant and rolling stock) was contributed by Messrs. Eugène Flachat and Mathieu. Owing to the special nature of this industry, the committee thought proper to confine themselves chiefly to collecting the most important statistical data relating to railways in France.

RAILWAY CONSTRUCTION.—On January the 1st, 1866, the total length of French railways for which concessions had been granted to the various companies amounted to about .... 21,000 kilometres, of which there were in operation .... 13,570 „

There remain to be completed .... 7,430 „

The total cost of the lines in operation amounts to 6,824 million francs (£272,960,000), of which 5,840 million were defrayed by the companies, and 984 million by the State. The expenses to be further incurred by the companies for the lines that remain to be completed, amount to about 1,900 million francs.

The lines completed cost, therefore, 500,000 francs per kilometre (£32,180 per mile), and those remaining to be completed are estimated at 255,000 francs per kilometre (£16,412 per mile).

With the exception of a few local and secondary lines, the whole net of French railways has been allotted to six great companies, of the working of which the following tabular statement gives a correct idea:—

Name of Company.	Kilometres. Conceded.	Kilometres. In operation.	Number of Locomotives.	Carriages.	Goods, Trucks, and Wagons.	Expenditure in francs. For Rolling Stock and Repairing Shops.	Expenditure in francs. For Plant.
Northern	1,613	1,197	519	1,032	13,123	92,172,022	....
Eastern	3,088	2,512	762	1,962	16,316	115,832,561	....
Western	2,520	1,857	514	1,770	10,160	85,734,3 42	....
Orléans	4,199	3,067	690	1,945	12,299	102,140,000	....
Paris, Lyons, and Mediterranean..	5,817	3,198	1,262	2,108	35,659	223,770,000	....
Southern	2,252	1,406	287	878	9,092	70,827,885	....
Total of 6 great Companies	19,489	13,327	4,064	9,695	96,649	690,476,810	647,265,800
Average per kilo. in operation	....	....	0.34	0.73	7.24	51,810	48,568
Minor lines	1,511	243	....	....	....	....	8,383,600
Total	21,000	13,570	....	....	....	....	655,707,968

WORKING EXPENSES.—In 1865, the expenses for working and keeping in repair the rolling stock amounted to about 36,650,000 francs, being 2,800 francs per kilometre; and the plant about 15,000,000 francs, or 1,150 francs per kilometre. Altogether this item amounted to 51,650 000 francs, or 3,950 francs per kilometre.

TRAFFIC.—The following general data result from the traffic returns of the French lines during 1865:—

Average number of kilometres in operation......	13,239
Total number of passengers	84,025,516
Average distance travelled over per passenger	40 kilometres.
Number of passengers × average number of kilometres	3,340,639,807
Total of goods carried	34,019,436 tons.
Average distance per ton carried	152 kilometres.
Number of tons × average number of kiloms.	5,172,824,825
Receipts from passengers	184,215,213 francs.
„ goods..	314,609,184 „
„ miscellaneous sources	80,032,474 „
Total gross income	578,856,871 francs.
= ...	£23,154,275

Average price of carriage:—

Per passenger and kilometre...............	0.0553 francs.
Per ton of goods and kilometre	0.0608 „
Total working expenses	266,202,095 „
Average gross income: expenditure...............	1 : 0.4598 „

PERSONNEL.—The *personnel* of the railway companies consists of the permanent staff, which is in some manner incorporated with the companies, and the *personnel en régie, i.e.*, the workmen of the repairing shops, labourers, and other hands whose employment is more of a temporary character.

On January 1, 1866, there were employed by the companies:—

On the permanent staff	60,160
Workmen, labourers, &c.	51,300
Total	111,460 men.

REPAIRING SHOPS.—The whole of the rolling stock is generally kept in repair by the companies in their own shops. The number of *employés* and workmen engaged in these amounts to about 20,000 for the whole of the lines, and the aggregate of their wages to about 23,350,000 francs, or 1,167 francs (£46 15s.) per man per annum.

Besides keeping their rolling stock in repair, some of the companies build their own engines and carriages. In 1865 they turned out 32 engines, 37 tenders, 32 carriages, and 2,570 waggons, the total cost of which was 9,180,000 francs.

In all the companies' workshops the piecework system (*marchandage*) is carried on on a large scale, by workmen clubbing together, and sharing the profits, in proportion to the rate of wages of each of them. The results derived from this system are most beneficial, and its organisation forms a nucleus for co-operative societies.

PRIVATE ENGINEERING WORKS.—Besides the companies' works, there are six establishments for the construction of locomotives; of these, two are in Paris, two in Alsatia, one at Creuzot, and one at Fives-Lille, turning out altogether some 450 engines and tenders per annum.

Railway carriages and waggons are built in nine private establishments, of which 6 are in Paris, 2 in Alsatia, and 1 in Lyons. These turn out about 1,500 carriages and 12,000 waggons per annum.

The aggregate value of all these constructions amounted in 1865 to 54,500,000 francs (£2,810,000), made up as follows:—

436 locomotive engines and 371 tenders...	26,700,000 francs.
1,439 carriages	8,000,000 „
31,056 waggons	19,800,000 „

These figures comprise the rolling stock imported from abroad.

These various industries give employment to some 10,000 hands.

WORKSHOPS AND FORGES for the supply of railway plant, besides rails, are to be found all over France. Their number is very considerable. Some establishments engaged in special branches of railway work are fitted up on a very large scale, but no statistical data on these can be given.

The manufacture of rails is concentrated in thirteen large ironworks situated in our coal districts. Of these, two are in the North, two in the East, three in the Loire district, two in the Bassin d'Alais, two in the Bassin d'Aubin, one in the Commentry, and one in the Creuzot district.

In 1862, being the year in which the production attained the highest figure, these works supplied a total of 205,000 tons of rails, worth about 40 million francs (£1,600,000). In 1865 the total supply amounted to 184,131 tons.

EXPORTATION.—The various engineering establishments exported in 1865:—

193 locomotives and 171 tenders, worth...	11,900,000 francs.
420 carriages, worth	2,700,000 „
1,868 waggons, worth	5,200,000 „
Total	19,800,000 francs.
=	£796,000

These figures, compared with those given as the aggregate production of France, show that more than one-third of the whole rolling stock manufactured during 1865 was exported.

Of rails, about 32,860 tons, worth 6,200,000 francs, went abroad in 1865.

IMPROVEMENTS IN PLANT AND ROLLING STOCK.—The improvements made during the last ten years in the construction of railway *matériel* consist chiefly in the greater power given to locomotives for ascending inclines of from 25 to 30 millimetres per metre (1 in 40 to 1 in 33.3), and dragging loads of from 600 to 700 tons on inclines rising from 4 to 5 millimetres per metre (1 in 25 to 1 in 20). Thus, their tractive power has been raised up to 7 tons.

The substitution of coal for coke has been generally carried out by using smoke-consuming apparatus, or heating the engines with well-selected close-burning coal.

The passenger carriages have been made more roomy and comfortable. Waggons are now constructed with greater solidity than heretofore. Their carrying power has not exceeded the limit of from 8 to 10 tons. In some special cases it has been carried up to 15 tons.

Various means for increasing the safety of trains and passengers have been devised, and are now being practically applied. Among these we may quote :—

1st. The electric apparatus for permitting railway guards to communicate with each other, and passengers to communicate with the guards, and which are being experimented upon on all the great lines.

2nd. The improvements in signalling on railways, by connecting the points with the signal-discs, and thus establishing a simultaneous action of both.

Moreover, railway brakes have been improved, but they have not ceased to work merely as moderators of the speed of trains; instantaneous action has, hitherto, been carefully avoided.

Next to powerful locomotive engines, much attention is also bestowed by engineers on small mining engines, which will prove of great utility in future years for the working of small local railways.

As regards the material used, we may mention the introduction of cast steel in the manufacture of plates for steam generators. Some endeavours are also being made for substituting iron for wood in the frames of carriages and trucks, and for railway sleepers.

Lastly, as regards the cost of manufacture, the following changes have taken place since the last French Exhibition :—The price of locomotives in 1855 averaged 2f. 10c. per kilo.; in 1866 it amounted to 1f. 75c. Tenders averaged 1f. 20c. in 1855, and are now about 90c. per kilo. The price of rails at the works was 320f. per ton in 1855; it is now about 185f. These figures will give a fair idea of the reduction in price that has taken place in all articles used for railways.

FRIENDLY AND PROVIDENT ARRANGEMENTS.—All the great railway companies have organised relief and superannuation funds for their numerous *employés*, and most of them contribute amounts proportionate to those paid by their servants. Besides, provision and clothing stores have been established on some lines, supplying necessaries at from ten to fifty per cent. below the usual prices. In the great centres of population there are also well-managed "refectories," in which workmen and other *employés*, as well as their families, may procure, at a very low charge, all articles of food ready prepared. They are supplied to railway servants on trust, up to an amount proportionate to their wages or earnings. At the time when bread was very dear, the companies used to give all their servants earning less than 1,500f. per annum, an advance corresponding to the rise in the price of bread.

Finally, it may be stated that the establishment of evening classes for the instruction of workmen, and of day schools for the children of all *employés*, tends, besides the institutions heretofore mentioned, to improve the moral, intellectual, and material condition of those engaged in the working of railways.

COAL BURNING PASSENGER LOCOMOTIVE.

Designed and constructed by Messrs. G. ENGLAND and Co., Hatcham Iron Works.

(*Illustrated by Plate* 317.)

Within a comparatively recent period, coke was almost universally considered the only proper fuel to be used in the furnaces of locomotives running on English railways. Two reasons may perhaps be assigned for this preference given to coke above coal: one arising from the fact that railway directors thought they were too prosperous to care about a little extra expenditure in the shape of fuel; the other resting with the engineers who, being perhaps influenced by the indifference of the directors, besides having to fight against the direct prohibition of the Government, did not seriously turn their attention to the subject. When, however, competition increased and dividends consequently diminished, the importance of working railways with the utmost economy became evident, and one of the most obvious reforms in that direction was the substitution of coal for coke.

When coal-burning was first adopted, few of the furnaces of locomotives were at all suited for the consumption of their own smoke, and the smoke nuisance began to assume considerable proportions; and as a necessary consequence a great number of plans, good, bad, and indifferent, sprang into existence which had for their object the prevention or at least the abatement of smoke.

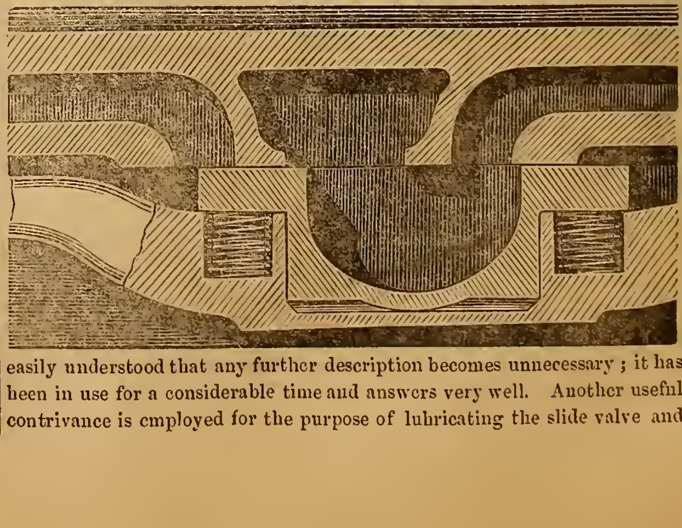
The universal abandonment of coke as fuel in locomotive furnaces is now in rapid progress, and a reversion to the use of the combustible in its normal condition as coal will, in the course of a few years, become an accomplished fact: it is, therefore, of immense importance to obtain a simple and efficient coal-burning, or smoke-consuming, furnace.

Amongst the various contrivances for effecting this object, one of the most efficient and by far the simplest we have seen, is fitted in the passenger locomotive illustrated in the accompanying Plate 317.

Figs. 1 and 2 are a longitudinal section and a sectional plan, and Figs. 3 and 4 cross sections of this engine. Fig. 5 is a cross-section showing the gear plate and the valve gear attached thereto. It will be observed that the bars of the furnace are considerably longer than usual, and are placed at an angle of about 30°, or at such an inclination that the jolting of the engine when running would cause the coals gradually to slide down the bars. Now it is obvious that if the coals are only placed just within the furnace door, or on the dead plate, the smoke given off by them will be consumed by the incandescent fuel at the other end of the bars, and as they jolt gradually down the bars, become, in their turn, incandescent and capable of consuming the smoke given off by a fresh charge of fuel, and thus the smoke nuisance is effectually suppressed, even when the commonest coal is used.

All railway engineers are aware of the time and trouble expended every night in removing the furnace bars to draw the fire and clear the grate, and any method, by which that labour could be saved, would be considered a great boon especially to the stokers. In this engine, the furnace bars never require removing, except for being renewed, as the fire can be drawn without disturbing them; this object is effected by having an iron plate the whole width of the furnace and about a foot broad, which turns on a pivot fitted at the end of the fire bars, and is actuated by means of a lever running up to the foot-plate and fitting in a catch fixed to the front of the boiler. If it is required to draw the fire, the lever is lifted out of the catch, when the wrought iron plate at the end of the furnace drops down and the fuel is shot out. In order to prevent the formation of smoke when the engine is standing, an auxiliary steam jet is fitted to the chimney to keep up a sufficient draught.

Besides the special feature of smoke-consuming, there are in this engine a few contrivances deserving of notice, such as the employment of a spiral spring fitted in the valve rod and pressing against the back of the valve to keep it up to the valve face. The method of carrying out this design is illustrated in the accompanying wood-cut, and may be so



easily understood that any further description becomes unnecessary; it has been in use for a considerable time and answers very well. Another useful contrivance is employed for the purpose of lubricating the slide valve and

piston; this consists in having a grease cup connected to the steam pipe just above its junction with the valve chest, and acted upon by the pressure of the steam in such a manner that it delivers a regular and constant supply while the engine is at work, but stops as soon as the steam is shut off.

These engines have been used on several railways, such as the Somerset and Dorset Railway, South Eastern Railway, Neath and Brecon Railway, &c., and have been found to be very economical of fuel, doing as much duty when burning coal as other engines with an equal weight of coke.

The following are some of the principal dimensions:—Cylinders, 16in. diameter, 24in. stroke; driving and trailing wheels 6ft. diameter; leading wheels 4ft. 6in. diameter; centre to centre of axles 7ft. 5in.; extreme centres 14ft. 10in.; length of framing 23ft. 8½in., length over buffers 26ft., length of barrel of boiler 9ft. 9in., diameter 3ft. 9½in. inside; two fire boxes (copper) 8ft. 1⅝in. long, copper midfeather, number of tubes (brass) 159, diameter of tubes 2in., length of ditto 10ft. 2in.; heating surface in fire box 139 square feet, ditto in tubes 845 square feet; weight of engine in working order:—on driving wheels, 10 tons 15cwt., on trailing wheels 10 tons 6 cwt., and on leading wheels 9 tons 9 cwt., total weight 30 tons 10 cwt. Tender, length over all 21ft. 1in., upon 6 wrought iron wheels 3ft. 8in. diameter, extreme centres 12ft. Carries 1,600 gallons of water and two tons of coal; weight about 20 tons in working order.

ON THE FRICTION OF SCREW PROPELLERS IN WATER.

By JOHN W. NYSTROM, C.E., Philadelphia.

Among the various resistances by which the useful effect of the motive power in steam vessels is affected, that due to the friction of screw propellers in water is one of the most considerable, absorbing, as it does, a large proportion of the power evolved by the engine. The following analytical deductions will go far to shew that the importance of the subject has hitherto been altogether underrated.

NOTATION OF LETTERS.

R = radius of the propeller in feet.
r = any radii less than R.
l = length of the helix for one whole convolution, and radii r, in feet.
P = pitch of the propeller in feet.
A = area in square feet of the helicoidal surface, for one whole convolution.
N = number of blades of the propeller.
n = number of revolutions per minute.
L = length of the propeller in feet.
v = velocity of the helix l, in feet, per second.
H = horse-power of friction.
f = friction resistance in pounds.
d = symbol of differential quotient.

It is found by experiments that the friction of surfaces of smooth castings moving in salt water, is about

$$f = 0{\cdot}0045\, A v^2 \quad \ldots\ldots \quad (1)$$

The differential area of the helicoidal surface on one side and for one convolution, is

$$d A = l\, dr \quad \ldots\ldots \quad (2)$$

Formula (2) substituted in formula 1, will give

$$df = 0{\cdot}0045\, v^2\, l\, dr \quad \ldots\ldots \quad (3)$$

The differential horse-power will then be

$$d H = \frac{0{\cdot}0045\, v^3\, l\, dr,}{550} \quad \ldots\ldots \quad (4)$$

$$\text{The velocity } v = \frac{l\, n}{60}, \text{ and } v^3 = \frac{l^3\, n^3}{60^3}, \quad \ldots\ldots \quad (5)$$

Substitute formula (5) in (4), and the differential horse-power will be

$$d H = \frac{0{\cdot}0045\, n^3\, l^4\, dr}{550 \times 60^3}, \quad \ldots\ldots \quad (6)$$

If, for brevity's sake, we call

$$\frac{0{\cdot}0045\, n^3}{550 \times 60^3} = \frac{n^3}{26{,}400{,}000{,}000} = X \quad \ldots\ldots \quad (7)$$

$$\text{then } d H = X\, l^4\, dr, \quad \ldots\ldots \quad (8)$$

$$\text{and } H = X \int l^4\, dr \quad \ldots\ldots \quad (9)$$

$$\text{The helicoid } l = \sqrt{4\pi^2 r^2 + P^2}, \text{ and}$$

$$l^4 = (4\pi^2 r^2 + P^2)^2 \quad \ldots\ldots \quad (10)$$

Formula (10) substituted in (9) will be

$$H = X \int (4\pi^2 r^2 + P^2)^2\, dr \quad \ldots\ldots \quad (11)$$

$$\text{but } (4\pi^2 r^2 + P^2)^2 = 16\pi^4 r^4\, 8\pi^2 r^2 P^2 + P^4, \quad \ldots\ldots \quad (12)$$

$$\therefore H = X \int (16\pi^4 r^4 + 8\pi^2 r^2 P^2 + P^4)\, dr \quad \ldots\ldots \quad (13$$

$$\text{and } H = X\left(\frac{16\pi^4 r^5}{5} + \frac{8\pi^2 r^3 P^2}{3} + r P^4\right) + C \quad \ldots\ldots \quad (14)$$

$$\frac{16\pi^4 r^5}{5} = 311{\cdot}71\, r^5, \text{ and } \frac{8\pi^2 r^3 P^2}{3} = 26{\cdot}319\, r^3 P^2 \quad \ldots\ldots \quad (15)$$

Let the friction horse-power be integrated from the centre of the propeller to the extreme radii R, then when $r = 0$, we have $C = 0$. Resuming the value of X, we have the friction horse-power for one convolution of the screw, on one side,

$$H = \frac{R\, n^3}{26{,}400{,}000{,}000}(311{\cdot}71\, R^4 + 26{\cdot}319\, R^2 P^2 + P^4) \quad \ldots\ldots \quad (16$$

In ordinary screw propellers, the helicoidal surface is cut up by a number of blades into small portions of the pitch, and when the helicoidal surface is counted on both sides of the blades, the friction horse-power will be,

$$H = \frac{R\, L\, N\, n^3}{13{,}200{,}000{,}000\, P}(311{\cdot}7\, R^4 + 26{\cdot}31\, R^2 P^2 + P^4) \quad \ldots\ldots \quad (17)$$

This includes both dragging and rotary friction of the propeller.

Example 1.—Required the friction horse-power of a propeller of the following dimensions:—Diameter = 20ft. or R = 10ft.; pitch P = 40ft., length L = 4ft. with N = 4 blades, making n = 50 revolutions per minute. Then

$$H = \frac{10 \times 4 \times 4 \times 50^3}{13{,}200{,}000{,}000 \times 40}(311{\cdot}71 \times 10^4 + 26{\cdot}319 \times 10^2 \times 40^2 + 40^4) =$$
$$= 374{\cdot}528 \text{ horse-power required for friction.}$$

Example 2.—In order to demonstrate how important it is to have a clear conception of friction in screw propellers, an extreme case may be referred to. Some seventeen years ago, an experimental vessel was built in Kensington, Philadelphia, intended for the very high speed of 20 to 30 knots per hour. The propeller was about 4ft. in diameter, with only one blade, extending through the whole convolution, and with a very fine pitch, about 6in. I do not remember the exact dimensions. The propeller was expected to make some 500 revolutions per minute. Required the friction horse-power of the above described propeller?

Diameter 4 or radius R = 2ft.; pitch P = 0·5ft.; number of revolutions n 500.

This case will be calculated from the formula (16). The blade extends through the whole of the convolution; but as the friction is required on both sides of the blade, we must use the coefficient in formula (17).

$$H = \frac{2 \times 500^3}{13{,}200{,}000{,}000}(311{\cdot}71 \times 2^4 + 26{\cdot}319 \times 2^2 \times 0{\cdot}5^2 + 0{\cdot}5^4 =$$
$$= 95 \text{ horses nearly.}$$

The whole power of the engine, calculated from the size of the steam boiler, would not exceed 50 horses; and the result was that, on the trial trip, the vessel could hardly crawl up against the tide.

The steamer was built with great secrecy in the backyard of a private residence, bordering on a creek. The builder and inventor kindly invited me to inspect her construction, and informed me that her performance was expected to astonish the world. The invention appeared indeed astonishing before the vessel was launched, but as her performance was not made public, she did not astonish the world.

LONDON WATER SUPPLY.

A project has lately been started by Mr. Arthur Sydney Ormsby, C.E., for supplying the metropolis with pure drinking water by suitable utilisation of rain. In the opinion of the author of this scheme it is impossible to obtain pure water for drinking and cooking purposes from the earth; or, at least, none of the plans proposed for realising a sufficient supply of pure water is likely to be adopted, owing to the great financial difficulties they would involve. Now, by collecting rain before it reaches the earth it may, by proper means of purification and storage, be distributed in an almost perfect condition for human consumption. Mr. Ormsby recommends that, at eight different points in London there should be artificial collecting grounds and surfaces, each covered with a light or ornamental glass roof, so designed that all the water falling upon it may run off into a receiving reservoir and pass thence into a settling, filtering, storage, and distributing reservoir, with which the main pipes would be connected. The space underneath, he suggests, could be used as a market, fruit or flower garden,

by the rents gained from which a large amount of the incidental expenses would be covered.

Mr. Ormsby adduces the examples of Brussels, Venice, Buenos-Ayres and British Guiana to show that his plan is perfectly practicable. He might have added that in Southern France, Italy, Spain, &c., many localities draw their supply of drinking water chiefly from cisterns and other receptacles in which rain is collected, and in some parts the people are almost entirely dependant on this resource, a great scarcity of water arising in times of drought. In some towns of Southern Germany there are generally two pumps to be found in the courtyards of the houses, viz., a drinking water and a rain-water pump,—the water derived from the former being used for drinking and cooking, that from the latter for washing purposes.

It is to be noticed that in all those countries people abstain from the use of rainwater for purposes of nutrition, wherever other sources are at hand; and naturally so, because the rainwater, owing to its greater softness, has not the strengthening effect and the general beneficial influence which water containing mineral substances will exercise on the human frame. In fact, it is only in times of epidemics that the use of distilled or very soft water is recommended by medical men; in ordinary times, its emollient action on the constitution is dreaded by all consumers. Now, it is a notorious fact, corroborated by the official statements of the Sanitary Commissioners of the metropolis,* that the composition of the London waters has been going on improving for the last fifteen years During that period the average amount of organic matter contained in water has been reduced from 2·46 grains per gallon in 1851 to 1·05 grains in 1866; and it is expected that by proper care and suitable arrangements, this substance will eventually be brought down to a minimum.

The author of the scheme under notice admits that "by a more careful conservation of the Thames, the New River, &c., it is possible to get a supply for all purposes except drinking and cooking." Seeing that these latter objects are just those for which the use of rainwater is not at all fit and proper, it is self-evident Mr. Ormsby's case becomes exceedingly weak, that, in fact, his project has no *raison d'être* whatever. No doubt the present mode of laying conduits of water in large towns is open to serious objections; the contamination of the contents of the water pipes by the escape of gas is doubtless detrimental to the quality of the water. Yet these and other concomitant evils may be remedied without much difficulty. Instead of a close juxtaposition, as practised at present, the two kinds of pipes may be laid at greater distances apart, so as to prevent the percolation of gas acting injuriously on the water. Many other ways are still open for improving its quality. At all events, as long as the present resources remain accessible and available, there is certainly no need, in Northern countries, of falling back upon the very primitive mode of obtaining a supply of drinking water by collecting rain in tanks or cisterns, though these may be designed on the "most improved" modern plan.

EAST INDIAN RAILWAYS.

The following statistics show the state and progress of railway traffic in India during the past two years. The lines are here arranged in the order of merit. It must be remembered that seven of them are not yet complete. The East Indian and Great Indian Peninsular were to join hands at Jubbulpore, and in these figures the extension of the latter to Nagpore does not show. The Bombay and Baroda has to be united with the East Indian at Delhi by a great line through Rajpootana. The Eastern Bengal is going on to Goalundo, and must yet run up by Dacca to Delroogbun on one side, and through Rajshaye to Darjeeling on the other. The Sindh has to run up the left bank of the Indus to the Punjab at Mooltan, and the Punjab to run down to Delhi; the section of the last from Delhi to Meerut is ready. The North Western Madras line has to tap the Nizam's country and join the Great Indian Peninsular at Goolburga.

Name of Line.	Mean Mileage open.	Total Receipts per Year.		Average Receipts per mile per week.	
	1866.	1865.	1866.	1865.	1866.
		£	£	£	£
East Indian	1,124¼	1,673,253	2,010,045	28·7	34·2
Gt. Indian Peninsular	733	1,171,120	1,249,839	37·4	32·5
Bombay and Baroda .	306	310,413	399,755	19·5	25·1
Eastern Bengal	110	123,505	129,792	21·5	22·6
Sindh....................	109	81,538	98,207	14·9	17·3
Madras	635	319,464	428,389	13·2	13·1
Great Southern	83	35,128	45,580	8·5	10·5
Mutlah	28	9,934	10,372	6·8	7·1
Punjab	253	54,125	94,098	5·5	7·1
	3,381¼	3,858,477	4,466,127		

It is expected that the Jubbulpore line from Allahabad will shortly be opened as far as Myhere, and an engine will run the whole of 224 miles. Already, before their completion, not ten years after the death of their great designer, the Marquis Dalhousie, the nine Indian railways yield a revenue of 4½ millions sterling. In three years, at the present rate of progress, Indian railways will yield nearly 7 millions, that is to say as much as the whole State revenue of Belgium. The great lines are to be completed by the Rajpootana, Indus Valley, and Peshawur extensions. It may also be noticed that the Government of India, moved thereto by the urgent representations of the Bengal Chamber of Commerce and Trades' Association, have lately repeated their earnest desire, expressed two years ago, that the East Indian Railway would complete their line by a bridge over the Hooghly at, and a terminal station in, Calcutta. It is urged upon the recusant shareholders that the interests of the company would be no less promoted by the carrying out of this undertaking than those of the Indian public in general.

OCEAN STEAMERS.*

Mr. George Allibon, late Resident Engineer at the Millwall Iron Works, has recently issued a pamphlet under the above head, giving the result of a largely extended experience of his views as to the conditions required of marine engines, and the kind of machinery which appears to him most efficient for that end. Mr. Allibon substantiates the statements he advances by references to the performances of well-known vessels of high character on long sea voyages, selected with a view to afford a fair comparison, irrespective of his own personal opinions or convictions upon the subject. From the extensive practical experience of Mr. Allibon —whom we have previously had occasion to notice favourably in The Artizan—as a designer and constructor of marine engines, the conclusions arrived at by him in the pamphlet before us are well worthy the attention of all interested in the important subject of steamship economy. The argument in Mr. Allibon's pamphlet is based upon the axioms laid down by the author, that economy in the consumption of fuel is demanded alike in the construction of engines for mercantile vessels and for ships of war; and that simplicity of construction is no less necessary, as viewed apart from the question of first cost (which is a matter of trifling importance in the Royal Navy); the simpler the engines, so that they perform the allotted work, the better are they adapted to the vicissitudes of weather and of war on distant stations.

Our author proceeds to name the most obvious desiderata in the marine engine under the heads of—

1st—Economy in the consumption of fuel;
2nd—Simplicity of constrnction;
3rd—Lightness and compactness;
4th—Power of working for long periods without adjustment or repair; and
5th—Cheapness in construction.

On the first head he remarks that, whilst the efforts of our most able and intelligent engineers have been directed to the construction of engines which shall work at a high indicated horse-power, on a small consumption of fuel, in many instances the introduction of the most modern appliances in the shape of double cylinders, superheaters, &c., which have been used for this purpose, involve such a greatly increased first cost of construction, such a complexity of their arrangements, and trouble and expense of

* See The Artizan for February 1, 1867, page 31.

* Ocean Steamers. By George Allibon, late resident engineer at the Millwall Iron Works. (London: Vickers and Harrington. 1867.)

repairs, as will prove serious obstacles to their general adoption, notwithstanding the satisfactory results, in point of fuel economy, which Mr. Allibon admits have, without dispute, arisen, in many instances, by the adoption of the class of improvements to which he refers.

Under the head of simplicity of construction, Mr. Allibon, after referring to some of the most cogent objections urged against complex marine engines, observes, however, that of late the pressure upon engineers to reduce the coal account in ocean steamers has led them, in many instances, to abandon all other considerations for this single end, and though he admits, in some cases, the desired result has been obtained, he asks the question, at what price?

Under the third head of lightness and compactness, the author remarks that these are relative terms, and must be understood within the limits of strength and utility; and that of two engines, identical in power, in cost, and in durability, that which is the simplest is usually the lightest, and occupies the least space, and that it will be conceded, under such circumstances, the lightest and most compact would be most suitable for marine purposes.

The author winds up his remarks under the fourth head—power of working for long periods without adjustment or repair—by observing that if it be admitted that the success of ocean steamers principally depends upon the capacity of their machinery, and that the efficiency of the machinery depends upon the accurate working of all its parts, it seems obvious that the fewer those parts, the less likely are they to become deranged, and the better adapted for the service of such vessels.

Upon the fifth and last head—cheapness in construction—Mr. Allibon remarks that if by any complex modifications in the machinery, the expense of the coal consumption can be reduced, a certain advantage will appear to be obtained; but before concluding that this advantage is not illusory, it will be necessary to compare the difference in the first cost of the engines, and the annual charges for depreciation. When these are taken in connection with their relative efficiency, a balance favourable to either system may be found. But if the simple engine performs equal work on an equal consumption of fuel, it requires no argument to prove its superiority.

Mr. Allibon then proceeds to enter into some very interesting particulars—the results of an opportunity afforded him of practically and completely testing the soundness of his conclusions—in connection with the steamship *Kaikoura*, whose very satisfactory performance, on a long sea voyage, we had occasion to refer to in THE ARTIZAN a few months since, and lest we may in any way diverge from the actual facts stated by Mr. Allibon, we will now allow him to speak for himself; he says:—

During my engagement as resident engineer of the Milwall Iron Company I was employed to design engines of 350 horse-power for the screw-steamer *Kaikoura*, built by Mr. Lungley for the Panama, New Zealand, and Australian Royal Mail Company.

Her destination was the new mail contract line between Wellington and Panama, a distance of more than 6,000 miles. The engines I designed were of the simplest construction, cutting off at one-eighth of the stroke, and furnished with surface condensers. On her official trial trip, her expenditure of coal was 2½lbs., nearly, per indicated horse-power per hour. This excellent result fully justified my anticipations, but to complete success there was still wanting the criterion of a long voyage. The subsequent performance of the *Kaikoura* on the pioneer voyage from Sydney to Panama, as attested by her log-book, has proved equally satisfactory. In a run of 648½ hours under steam, the *Kaikoura* traversed 6,150 miles, at an average speed of nearly 10 knots per hour. Although supplied with colonial coal, which, for steam purposes, is greatly inferior to that of our own mines, her consumption during this long voyage scarcely exceeded 3lbs. of coal per indicated horse-power per hour. The engineer reports that the working of her engines was in every respect satisfactory. The *Kaikoura* has since performed the voyage repeatedly without accident or derangement. Her success may, therefore, be received as an established fact, and, I think, may fairly be adduced in support of my design as a proof-test of no ordinary character. No other steamships in the world perform so long a voyage without interruption, and, with the exception of the Cunard line, no vessels on long sea voyages have attained a higher average rate of speed. This is the more remarkable from the fact that the "lines" of the *Kaikoura* are not such as are calculated to insure speed. The *Ruahine*, a vessel of similar dimensions, built by Mr. Dudgeon for the same company, accomplishes an equal speed with 168 indicated horse-power less than the *Kaikoura*.

Having premised that the *Kaikoura* is not, in many respects, a favourable example of vessel to do even justice to the efforts of a marine engineer, the author now compares her performances with those of a vessel in every respect her antithesis—viz., the *Moultan*, a magnificent screw steamer, built for the Peninsular and Oriental Company, engined with double cylinders, and probably the most perfect vessel in the splendid steam fleet of that company; he says:—

In comparing the *Moultan* with the *Kaikoura*, I am taking the best of a high class of vessels, furnished with engines 30 per cent. more costly, supplied with coal of very superior quality, and employed in voyages of shorter duration. If, under such conditions, the *Kaikoura* will bear the comparative test, I think I may fairly claim recognition of my views.

Name of Ship.	Nominal horse-power.	Consumption of Coal in lbs. per indicated horse-power per hour.	Average speed in knots per hour.	Number of hours under steam.
Moultan	500	2·9	9·86	552
Kaikoura	350	3·1	9·97	648.5

If, in the above consumption of fuel, due allowance be made for the inferiority of the coal supplied to the *Kaikoura*, the comparison will be, at all points, highly favourable to that vessel. As the other vessels in the Peninsular and Oriental Company are inferior to the *Moultan* as regards speed and consumption of fuel, it is unnecessary to multiply instances from among the steamers of that company.

Subjoined is a list showing the comparative merits of five vessels belonging to the fleet of the West India Mail Company. In all these the consumption of fuel in proportion to the indicated horse-power is largely in excess of the *Moultan* and *Kaikoura*.

Name of Ship.	Nominal horse-power.	Consumption of Coal in lbs. per indicated horse-power per hour.	Average speed in knots per hour.
Douro	500	3·55	10·37
Rhone	500	3·36	8·75
Eider	310	3·13	8·03
Tasmanian	744	3·74	11·29
Oneida	472	3·91	10·70

Hundreds of examples might be instanced still more favourable to the *Kaikoura*, but I have confined my attention to the ships of the two great mail-contract companies, as, owing to the length of their voyages and local circumstances, they have, perhaps, more than most other companies, endeavoured to solve the question of a high average rate of speed, in combination with a small consumption of fuel.

Mr. Allibon now further dwells upon the superiority of the *Kaikoura*, as compared with such steamers as are expressly designed with a view to reduce the coal bill *quand même*, and adduces in support of his opinion, the authority of Mr. Bowman, the Superintendent of the Panama, New Zealand, and Australian Royal Mail Company, whose duty it had been to represent the company on the trial trip in the Channel.

In conclusion we would remark that Mr. Allibon's statements are so eminently practical and useful that we repeat the recommendations contained in the commencement of our notice, and all interested in the subject of steamship economy will do well to give a careful and impartial consideration to Mr. Allibon's observations, supported as they are by the facts which he adduces in support of his views.

SPEED AND FARES ON BRITISH AND FOREIGN RAILWAYS.

The report of the Royal Commission on Railways, recently issued, contains—besides statements of the financial condition of the various lines, suggestions for increasing the stability of these undertakings, and much other valuable matter—some comparative views of the working of British and Continental lines. We here extract the data respecting the speed of railway trains and the height of the fares, some of which are, however, too vague to admit of an exact appreciation of the facts. The *average* speed on Continental lines, in particular, might have been given with more precision.

SPEED OF TRAINS.—In the United Kingdom, express trains run generally, including stoppages, about 40 miles per hour; the average of all the examples of the quickest trains (omitting local and suburban) gives 36½ miles per hour; the ordinary trains run generally from 18 to 30 miles per hour; whilst the average of all the examples of the slowest trains gives 19½ miles per hour. In France the figures stand thus:—Express trains, including stoppages, 25 to 35; average of the quickest examples, 31; ordinary trains, 16 to 25; average of slowest trains, 18 miles per hour. In Belgium the quickest trains run from 29 to 35, the slowest from 18 to 23 miles per hour. In Prussia, the quickest 29 miles, the slowest 17 to 21 miles. In Austria, the quickest 20 to 29 miles, the slowest 14 to 21. In Bavaria and along the Rhine, the quickest 24 to 32, the slowest 13 to 24 miles. In Italy the quickest 24 to 30, the slowest 15 to 24 miles.

RAILWAY FARES.—The following table, compiled from the report under notice, exhibits the average height of railway fares per mile in the principal countries of Europe:—

	1st Class.	2nd Class.	3rd Class.
Average of 12 principal Railways of England	2.11d.	1.51d.	0.92d.
France	1.73	1.30	0.95
Prussia	1.57	1.17	0.80
Austria	1.87	1.41	0.94
Belgium	1·23	0.93	0.62
Bavaria	1.33	0.89	0.60
Rhineland	1.53	1·05	0.70
Italy	1.88 to 1·47	1.50 to 1.19	1.02 to 0.85

On some Prussian and Rhenish lines, and in some of the mining districts of Southern France (such as the Cevennes, &c.), there is also a fourth class, the fare of which averages one-half of the third-class. In most fourth-class carriages no seats are provided for the passengers.

It is to be borne in mind that return-tickets are more generally issued in this country than abroad, and usually on more liberal terms, and that the regulations as regards passengers' luggage are less liberal on the Continent than in England. The general result of a comparison between England and France may be stated to be that first-class passengers in England, availing themselves of the fast trains for long distances, are carried at higher speed and at somewhat higher fares; but in France persons travelling by ordinary or third-class trains are carried at a lower rate than in England, and with more frequent trains.

It should be observed, however, that the accommodation for first and second-class passengers on most Continental lines, but chiefly in Southern Germany, is far superior to that in Great Britain. The style, for instance, in which the second-class carriages on the Baden and Wurtemberg Railways, and the Eastern Railway of France, are built and fitted, is fully equal to that of first-class carriages in this country. On the whole, it may be said that, as regards the average speed of trains, the traveller on British railways enjoys advantages entirely unattainable on most Continental lines; whilst, on the other hand, the passenger accommodation is generally inferior in England to what it is in Central Europe.

COMPENSATION FOR RAILWAY ACCIDENTS.

In their report recently issued, the Royal Commission on Railways recommend that railway companies should be held absolutely responsible for all injuries arising in the conveyance of passengers, except those due to the negligence of the passengers themselves; but that, on the other hand, a *maximum* amount of compensation should be fixed for each class of fares; however, any passenger should be entitled to require from the company any additional amount of insurance he may desire, on paying for it according to a fixed tariff. To prevent frauds, it is proposed that compensation claims should not be admitted, unless made within a certain period, and that companies should have the right of medical examination of the claimant. Sir Rowland Hill, in a separate report, supports the proposition that everyone's recompense for injury should be in proportion to his payments, as in case of fire, marine accidents, or ordinary life insurance, but suggests the following arrangement:—"The payment in case of death to be a certain fixed multiple of the single mileage fare, say, for instance, in the ratio of £100 for a penny; so that the heirs of a passenger killed in travelling at the rate of 1d per mile would receive, independently of insurance, £100, while those of a fellow-passenger killed in travelling at the rate of 3d. per mile, would receive £300, minor injuries being paid for in proportion, and so far as possible to some fixed scale. Of course, the multiple may be fixed higher or lower, as may be desired. A similar rule to be extended to luggage." By the adoption of the proposal of the Commission, "that railway companies should be held *absolutely* responsible for all injuries, except those due to the passenger's own negligence," the recent decision of the Court of Queen's Bench (reported in another page of our present issue), by which companies are declared not liable for accidents arising from *latent* defects, would be invalidated.

INSTITUTION OF CIVIL ENGINEERS.

EXPERIMENTS ON THE REMOVAL OF ORGANIC AND INORGANIC SUBSTANCES IN WATER.

By EDWARD BYRNE, M. Inst. C.E.

It was premised that the object of these experiments was to try how far the statements generally made, with regard to the action of charcoal in purifying water, might be depended on. They were not undertaken to support any theory, but rather to satisfy the author himself, who observed every precaution to obtain trustworthy results.

It was stated that many substances were spoken of as having a purifying effect on water, but of all charcoal (especially animal charcoal) had been considered the most efficacious. Though in works which treated on spring and river waters, the assertion was constantly made that both vegetable and animal charcoal (particularly the latter) removed the organic and inorganic substances found in waters, yet no experiments were given by which to judge to what extent these statements were true. With a view to ascertain whether water, uncontaminated by either decomposing animal or sewage matter, but containing dissolved vegetable matter, would contain any nitrogenous bodies, some bog water was procured from a locality that precluded the possibility of its containing any animal or sewage matter, the experiments on which served to prove that, in bog water at least, vegetable nitrogenous matter was present.

After some observations to the effect that nitrogenous organic matter might exist in water in an innocuous state, and that as putrefactive nitrogenous matter was the most hurtful of all substances that could exist in water, the author remarked how much it was to be regretted that, by chemical means, no distinction could be made between the nitrogenous organic matter which existed in a putrefactive, and that which existed in a non-putrefactive state.

The details of four sets of experiments were given, the first on animal charcoal, of which nearly 5lbs., new and freshly burned, and of the degree of fineness used in sugar refineries, were packed in an ordinary stoneware filter. The water employed (of which a complete analysis was given) contained, in the gallon, organic matter, 10·80 grains; inorganic matter, 88·30 grains. The hardness of the water before boiling, was found to be 50·50°, and after boiling, 33°; and the oxygen required to oxidise the organic matter contained in one gallon, amounted to 0·0116 grain. Several gallons of the water were allowed to percolate slowly through this charcoal, and upon examination afterwards it was found that, of the inorganic matter which had originally existed, 52·60 grains were removed from the first gallon; but from each succeeding gallon less and less; so that, from the twelfth gallon of water that passed through the charcoal, only 8·80 grains of inorganic matter were removed. Of the organic matter 4·80 grains were removed from the first gallon; but with a gradual decrease, the charcoal ceased to remove any organic matter after the sixth gallon. In fact, immediately afterwards it commenced to give back a portion of the organic matter removed in the first instance, the quantity returned to the twelfth gallon amounting to 1·55 grain. Thus, of the 13·54 grains of organic matter removed by the charcoal from the first six gallons of water, as much as 4·98 grains were given back to the next six gallons; from which the author concluded that, had this set of experiments been carried a little farther, all the organic matter removed at first by the charcoal would have been given back again.

The second and third series of experiments were with wood and peat charcoal, which, however, were still less satisfactory than those with animal charcoal. The fourth set of experiments was on animal charcoal, with water previously treated with permanganate of potash slightly in excess. After remarking that the water, in its passage through the charcoal, was found to contain organic matter apparently in the same quantity as before treating it with the permanganate, attention was drawn to a comparison between the first and fourth sets of experiments, to show how closely they agreed to contradict the general statements made as to the removing power of charcoal, and to demonstrate how very little indeed could be done by this filtering material, even on a small scale, towards the purification of water.

The author then said that as the epidemic which had so recently left these shores, might return again before the adoption of any scheme to supply the metropolis with an abundance of pure water, he thought it would be well, if only to check its ravages in ever so slight a degree, to experiment on various materials which were believed to possess the power of removing organic matter: but, to obviate false conclusions, and to render such experiments practically useful, they must be systematic.

In conclusion, he gave it as his opinion that, as by chemical agency bad water could be purified to a very limited extent only, the public mind should more than ever be given to the great question of supply; and, as people valued their lives, they should, above all things, in their choice of a source, not be too much influenced by distance, but be willing to undergo the necessary expense of securing the object of their search, not only in abundance, but in the greatest purity.

At the monthly ballot, taken on May 21st, the following candidates were balloted for and duly elected:—Messrs. John Daglish, George Baker Forster, Charles Hawksley, William Wilson Hulse, Thomas Graiuge Hurst, Robert Valentine John Knight, Dr. Manuel Buarque de Macedo, and Dr. Francisco Pereira Passos, as members; Messrs. Wilfred Airy, Henry John Card Anderson, Imrie Bell, Isaac Lowthian Bell, Lieut.; Edward James Castle, R.E.; Messrs. James Timmins Chance, M.A., William Fothergill Cooke, Samuel Thomas Cooper, Charles Baxter Cousens, Henry Halford Coventry, William Gray Ferrar, John Parson, Joseph Potts, Thomas Prosser, and Lieut. John Barnes Sparkes, as Associates.

INSTITUTION OF NAVAL ARCHITECTS.

THE DEPTH OF SHIPS.

By MR. EUGENE FLACHAT.

The conclusions at which I have arrived do not agree with the ordinary traditions of naval construction. I designedly make use of the term *traditions* instead of *rules*, because, notwithstanding persevering search, I have been unable to find in any treatise, memoir, or paper whatever any law or principle for the determination of the depth, in relation to the other dimensions, of a ship. Now, in the conditions both of tension and compression caused by change of form, depth is the most important element of rigidity which a ship, considered as a girder, can present, to counteract changes of form in a vertical direction.* The breadth has the same effect on horizontal bending strains. The advantages of depth, viewed in relation to the structural strength of the hull, are so marked that it is worth while to see how far it may be increased without the vessel's losing its good qualities as a ship. Depth has also another advantage, that of raising the deck well above the water level. It is by carrying away projecting features on the deck, and by tearing off the hatches or coverings of openings left for passage or ventilation that the sea finds its way inside a ship, putting out the engine fires, and endangering her flotation. The higher the ship is, the less the deck is exposed to be swamped by shipping seas. There are two things which save the deck from destruction: the first, that it is in general only the crest of the wave which gets inboard, and that thus the quantity of water which

* The square of the depth enters into the formula of resistance to a bending couple acting in a vertical plane.

is shipped varies inversely with the height of the deck above water; secondly, and it is this which has the greatest effect in keeping the ship free, there is the tendency of the ship to rise to the waves, and this tendency is in an inverse ratio to its heaviness. I call the heaviness of a ship its weight divided by its volume. Now, the way to diminish the heaviness of a ship is to increase the ratio of its volume to its weight.

If a ship's displacement be 1,000 cubic metres forward, and 1,000 aft, and its volume be 4,000 cubic metres, of which 2,000 only are immersed, a sea, which can come on board, must exert, in lifting the ship, before it can do so, an effort which will vary directly at this height, until it shall have reached the limit of complete immersion of the ship. At that moment the effort of immersion will be equal to 2,000,000 kilogrammes, multiplied by the height of the wave which floods the ship, measured from the load-water line, and then the ship will emerge with considerable violence. This leads to the inference that the height of ships out of the water tends to diminish the danger of shipping a sea, and may even go so far as to get rid of this risk completely. It remains to be seen whether freeboard (that is to say, the depth of a ship) can be increased without diminishing its nautical qualities.

The quality of a ship which takes precedence of all others is stability. Does this depend on the height of a ship out of water? The stability of a ship depends on certain relations of the form and dimensions of the immersed portion of the hull, and on the situation of its centre of gravity. Stability of form is not unfrequently distinguished from stability of weight; but in reality these two sources of stability are inseparable, seeing that they form the two parts of a couple which tends to right the ship against any couple applied to upset it, or make it heel. The effect of heeling is generally to increase the surface of the water section, and invariably to raise the centre of weight, so that the heeling tendency is always more or less counteracted by the tendency of the action of gravity to bring the centres of figure and of weight into the same vertical line. In the calculations of stability, the form and dimensions of the hull are only of importance, so far as they are, or may become, immersed. In so far as any portion of the topside, which is out of reach of immersion, has no effect, either statical or dynamical, on the centre of gravity, it does not affect the stability. In other words, if the part of the ship which is always out of water, and remains so at the greatest angles of inclination, had no weight, its form and its height would have no influence on the behaviour of the vessel. It is, therefore, only the relative weight of the upper works, and its dynamical action, that need be considered. I propose to simplify the treatment of the question by confining myself to examining it with reference to the requirements of Transatlantic packets.

The Transatlantic steam-packet is a vessel built for steaming at all draughts from light to load. At first, that is to say, at its launching draught, and later, when its engine is on board, but no coals or cargo, its centres of weight and of figure must lie exactly in one and the same vertical line; and this property must hold throughout all its variations of lading, both with coal and cargo. Stability is just as necessary to it at its light as its load immersion. The vessel must be in equilibrium in both conditions to this extent, that the weights and their moments taken with reference both to the centre of weight and to the centre of gravity, should be equal, or should approach as nearly as possible to equality.

The addition to the light displacement of the coal and merchantable cargo should produce no change in its nautical properties, except an increase of immersion; and, if the vessel is well constructed, that will not produce any marked effect on its periodic time of rolling or pitching. Lightening the draught tends to diminish the righting couple, owing to the rise of the centre of gravity due to the consumption of coal, and the increase of the moments of the top weights tends to increase the amplitude and duration of the rolling period, but these effects are restricted within narrow limits if the ship has been well designed.

Within the belt comprised between the light and load lines due to the consumption of coal on the passage, apart from cargo, the water-line is practically unaltered in form amidships, and undergoes no serious variation forward or aft, and thus the moment of inertia of the plane of flotation undergoes no marked change. It undoubtedly happens sometimes that a vessel has not sufficient stability of form, that is to say, that the surface and moment of inertia of the water section diminish too rapidly as the vessel lightens, and that the centre of gravity rises. If then the vessel heels, it takes a permanent list, whether the heeling may have been due to the effect of wind or to some slight inequality of lading, or whether the rise of the centre of gravity may have produced indifferent equilibrium, with reference to its weights; but this is a defect of design easily remedied, for the stability may be measured, at all stages of immersion, like a weight in the scales. In the present day an error in the stability of a ship is unpardonable on the part of the designer; but we must still expect that for a very long time the want of instruction of mariners will endanger the stability of merchantmen by the bad distribution of the cargo.

The Transatlantic packet differs notably from the freight-carrier, because its light and load displacements differ but little. The weight of coal and cargo together make up but one-third or one-quarter of the displacement. Moreover, the spaces in which these weights are to be placed are settled beforehand, and their influence on the rolling and pitching can be completely measured. There need therefore be no error, and we may say that, with regard to its qualities as a sea-boat, a Transatlantic packet ought to have no element left uncertain, for the mathematical conditions of its design are to be absolute and simple, inasmuch as all the formulæ on which they depend are directly reducible to equations of form, of weight, and of moments.

Nevertheless, if a practice has arisen by virtue of which vessels are built so as to incur risk of destruction at sea for want of sufficient freeboard, there must be some reasonable cause for this practice. It cannot be assumed that the reasons why vessels are usually low in the water are particular to each ship. For some of them, doubtless, one reason may be the objection to receive the whole force of a wave against the bow, and another, the effect of the wind on the hull. Even so, the first object is doubtful. It is difficult to determine whether more work is lost in steaming ahead with part of the deck under water, or in rising to the wave and cutting through its ridge. At any rate these considerations do not apply to Transatlantic packets. For these vessels it is important that the deck should be kept as comfortable as possible, especially in rough weather, when the passengers suffer mostly below. Now this involves two postulates—easy rolling and a high deck. These two conditions, far from being contradictory, agree, for this reason, that the moment of the topweight increases the period of rolling at the same time that it diminishes its amplitude. We are thus led to assume that the want of depth in ships is due to the traditions of wooden shipbuilding. It is a consequence of the use of timber that its scantling, and consequently its weight in the topsides and upper decks, differs but little from the scantling and weight of the immersed portion of the hull, and this consideration assigns a hint to the ratio of freeboard to draught. Without some such limiting ratio, if the topsides were too heavy for the under-water works, it would be necessary to ballast the ship before launching her. This consideration explains all the peculiarities of wood-built ships. It accounts for the variation of breadth of beam in ships of war, which depends on the number and height of the fighting decks. It accounts equally for the low freeboard of merchantmen, which, in case of their finding no cargo at their ports of call, would be obliged to ballast heavily, if their topsides were out of proportion to their light displacement.

But this motive which, in wooden shipbuilding, so emphatically limits the depth of ships, has far less importance when the ship is iron built. It is much easier to obtain the requisite strength in iron than in wood, and this strength increases with the better quality of the iron. It is easier to obtain a rigid truss with wrought iron than with cast iron, and with steel than with wrought iron, so that we may obtain the same strengths with less weights by using the stronger materials. Now, if this be true as a general axiom, it holds a portion when the resisting material can be distributed over the structure, so as exactly to meet the distribution of the forces both in direction and in amount. Of this character is the girder, whose material is chiefly massed at top and bottom, because the central portion has but little work to do. So also is the hollow pillar; its material being arranged so as to increase the diameter, increases the ratio of breadth to length, and thus allows a heavier weight to be borne at the same height, or an equal weight at a greater height. In designing the upper works of a ship, it is easy to contrive the distribution of material, so as to obtain the greatest possible strength of structure as a whole, and, seeing that the height enters by its square into the formulæ of resistance, the weight of the upper works will admit of a diminution, not in a direct ratio, to the increase of height, but in a certain relation to it, as the depth increases. These remarks show that the depth of iron ships, and consequently their freeboard, might be much increased, without any proportional increase in the weight of the upper works, and without any change in the form of displacement.

Finally, we may conclude that the depth of ships, as regards freeboard, is in general insufficient, as it exposes the deck too much to the sea; that as regards structural strength the increase of depth is advantageous; that as regards ease in a seaway, increased freeboard is an element of comfort and safety; that by the use of iron in construction, the depth can be increased without interfering with the sailing qualities or speed of the ship, because it affects the weights only, or rather the positions of the weights in relation to the form of the ship, without affecting the form; and, lastly, that the insufficient depth generally given to ships is due to the traditions of wooden shipbuilding.

ROYAL COMMISSION ON TRADES' UNIONS.

THE AMALGAMATED SOCIETY OF ENGINEERS.

(*Continued from p. 142.*)

On the questions of strikes, increase of wages, and decrease of working hours, the witness was examined at very great length. After the great strike or lock-out of 1852, the funds of the society fell to £3,000 in hand, and 2,000 members left out of 12,000. After that a levy of 6d. a week each man, in addition to the ordinary subscription, was made in order to realise a fund. There has been no strike since 1852 of any importance, but if there were to be, the society would call on the members to subscribe a sovereign or half a sovereign, so that there is no fear of the fund going down.

Mr. Hughes: It is very difficult for a strike to happen in your society, I believe? What measures have men to take, for example, before they can strike in your society?

Witness: They have to represent their grievances to the committee of their branch. In a town where there is more than one branch, there is what is called a district committee, composed of seven members from the different branches, or more in proportion to the number of branches in the district; and instead of the branch committee dealing with the question, the district committee deals with it, because there is a larger representation. For instance, here in London we have a district committee composed of twenty-four members, because we have twenty-four branches in the district; and when any dispute arises in the district the whole of the twenty-four branches are represented, thereby bringing about a proper understanding in relation to the question at issue, and affording a better opportunity for arriving at a satisfactory conclusion. If the men who wish to go out have obtained the consent of their branch in their own town, they would require to get the consent of the district committee, and the approval of the executive council.

Mr. Hughes: Therefore, unless approved in the first place by the branches of their own town, and in the second place by the central executive council, no members of your trade can strike?

Witness: No; or, at least, they ought not to strike.

Mr. Hughes: That is to say, they would not be supported if they did?

Witness: I would not take upon myself exactly to say that, because a great deal would depend upon the nature of the case. If some employer, for instance, went and said to his workmen, "Your wages after to-morrow night will be reduced three shillings a-week," in all probability the men would leave there and then; in that case we would consider them entitled to the benefits of the society." But as the ordinary rule they would require to get first the consent of their own branch, and then that of the executive council. Where there is time, and upon the consent of the executive council being given, the men may go out and get their allowance.

The advance in wealth and strength of the society has tended to make strikes in the trade less frequent than they were formerly, and there have been fewer trade disputes, with lock-outs and strikes, during the last fifteen years than during the preceding fifteen years. Now, when men have grievances, they wait upon their employers by deputations, and the council of the society give advice. I should say that members generally are decidedly opposed to strikes, and that the fact of our having a large accumulated fund tends to encourage that feeling among them. They wish to conserve what they have got; as I have heard it put here, the man who has not got a shilling in his pocket has not much to be afraid of, but with a large fund such as we possess we are led to be exceedingly careful not to expend it wastefully, and we believe that all strikes are a complete waste of money, not only in relation to the workmen, but also to the employers. The society have recommended that no strikes should take place in twenty cases in as many months in this trade. Wages have fluctuated little during the last ten or twelve years, but during the last year there has been an upward tendency. The society have certainly not maintained more than six strikes during the last ten years directly for the purpose of raising wages. The strikes which have occurred have principally arisen "from piece-work and the large number of boys employed," and for "regulating the trade."

Mr. Roebuck: Why should you prevent a master from employing boys who can do the work?

Witness: We have a perfect right to say to him, "If you employ a certain number of boys beyond what we conceive to be the proper number, we will not work for you."

Mr. Roebuck: A proper number means the number that you like?

Witness: What the men think right.

The society men regulate their affairs without dependence upon the non-society men; but if the latter fall in with the society men's views, "well and good." Occasionally the two classes hold a meeting, and, generally speaking, if there is anything in the nature of a strike, the non-society men leave their employment as well as the society men.

On the question of foreign work, the witness expressed no fear that continental manufactures would ever successfully compete with the English, and he said: I may just state that trades' societies are being established in France and in Belgium rapidly, and they will have the tendency of raising the wages, and thereby remove that fear of competition that our English friends are so much alarmed about.

Mr. Matthews: Do you know anything of wages in France and Belgium, as compared with England?

Witness: Our members employed in France are getting from £2 to £2 10s. per week. The same class of men, in all probability, would be getting here 36s. per week.

Mr. Matthews: What do the ordinary French and Belgian workmen get? I wish to draw a distinction between the highly skilled workmen, which, I dare say, those are who go out from your society to work in France, and the ordinary skilled workmen in Belgium and France?

Witness: I do not know personally; I only go from hearsay; but I am given to understand that it is from four to six francs per day. If they are getting five francs a day, it would be, say, 4s. 2d., against some 6s. here.

Mr. Matthews: Assuming the ordinary rate of wages to be thirty per cent. lower in France and Belgium than in this country, and that workmen improve in France and Belgium as they do here, what is to prevent work going from this country to France and Belgium?

Witness: I cannot answer that question as to what eventually may turn up, but at the present time I see nothing to apprehend. I believe, in the first place, that the Englishman does as much work in six days as the Frenchman can do in eight. Under the system on which they work there, men being allowed to smoke their cigars while at work, and to enjoy themselves in that kind of way, it is impossible for them to do the same quantity of work as they do in England.

Mr. Matthews: Is it not the fact that the manufacture of locomotives and other engines has very much increased in France and Belgium in the last ten years?

Witness: I believe it has. I do not think that France and Belgium will stand still in that respect or any other. I believe nations will progress, because it is in the nature of things that they should.

The witness also stated that the society received information as to work going on in different parts, and they used this information for the benefit of the members; and after some other details had been given the witness's evidence closed.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

At the last monthly meeting of the executive committee of this Association, held on May 28th, 1867, William Fairbairn, Esq., C.E., LL.D., F.R.S., President, in the chair, the Chief Engineer, Mr. L. E. Fletcher, presented the report for the three months ending May 24th, of which the following is an abstract:—

During the last three months (*i.e.*, from February 23rd to May 24th, 1867) 630 visits of inspection have been made, and 1,381 boilers examined, viz., 961 externally, 33 internally, 2 in the flues, and 385 entirely; in addition, 9 have been tested by hydraulic pressure. The number of defects, omissions, &c., discovered amounted to 339; of these 214 were defects in boilers, 83 defective fittings, and 95 omissions of fittings, besides one case of deficiency of water. There were 16 cases of dangerous defects, viz., furnaces out of shape, 2; fracture, 7; internal corrosion, 2; external corrosion, 3; safety valves out of order, 1; pressure gauges out of order, 1.

Explosions.

On the present occasion I have nine explosions to report, which resulted in the death of seventeen persons, as well as in injury to fifteen others. Details of five of these explosions will be found below. It will be seen that they arose, as usual, from the simplest causes, and that they might have been prevented with ordinary care. Not one of the boilers in question was under the inspection of this Association.

Tabular Statement of Explosions, from February 23rd, 1867, to May 24th, 1867, inclusive.

Progressive Number for 1867.	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
6	Mar. 12	Portable Multitubular. Locomotive type	1	2	3
7	Mar. 19	Portable Multitubular. Locomotive type	8	4	12
8	Mar. 23	Colliery.—Particulars not yet fully ascertained ...	3	1	4
9	Mar. 29	Plain Cylindrical. Externally-fired	2	0	2
10	Apl. 10	Single-flue, or Cornish. Internally-fired	1	0	1
11	Apl. 20	Plain Cylindrical. Externally-fired	1	2	3
12	May 10	Locomotive. Internally-fired	1	1	2
13	May 11	Plain Cylindrical. Externally-fired	0	2	2
14	May 18	Single-flue, or Cornish. Internally-fired	0	3	3
		Total..................	17	15	32

No. 6 Explosion, by which one person was killed and two others injured, occurred at twenty minutes past eleven on the morning of Tuesday, March 12th, at a steam saw mill.

The boiler was of patent multitubular construction, and of the locomotive type, with a slight variation, having a second or return set of flue tubes passing over the fire box, while the chimney and smoke box were at the front instead of at the back of the boiler.

The boiler was reduced on its explosion to a complete wreck, the outer casing of the fire box being ripped off from the inner one, and both torn from the barrel, while the tubes were pulled out from the two front tube plates, the wheels dismantled, the parts all scattered, and a portion of the fire box hurled upon the roof of an adjoining dwelling house.

At the coroner's inquiry into the cause of the explosion, the owner of the boiler stated that "he had had a good deal of experience with portable engines and boilers, and considered himself competent to judge whether they were in good working order or not. He drove the whole of his mills with them and had bought a good many, having had four new and seven old ones. The exploded boiler was twelve years old, but he thought it safe to work on for twice that age, though nothing was said as to the necessity of making frequent internal examinations during that period, to see whether the plates were wasted by corrosion or not, though they did not exceed a quarter of an inch in thickness originally. A new boiler, he stated, was a rarity, and new ones very often exploded. He had not discovered any weak places in the boiler, nor did he consider any particular part had given way, but thought that the explosion had been a general one. The explosion, in his opinion, had been caused by the boiler being but partially clothed, the cylindrical barrel only being lagged, and not the outer casing of the fire box, while the weather had been cold and windy on the morning of the explosion, and the water level allowed to rise two inches above the ordinary mark. He came to the conclusion that the amount of water had a good deal to do with the explosion, because 'water was very turbulent, and he believed it would burst a boiler quicker than steam,' while as the plates had rent at the line where the covering on the boiler ended, he thought that the boiler had burst from 'atmospheric influences,' in consequence of being but partially clothed on a cold, frosty morning."

Fortunately the coroner was provided with other scientific evidence, or no satisfactory information would have been given as to the cause of the explosion.

and it might have been attributed either to the supposed negligence of the deceased fireman in admitting to the boiler too much "turbulent water" by two inches, or to the newly-invented theory of the atmospheric influence upon half-naked boilers on cold, frosty mornings.

The other scientific witness referred to was the district locomotive superintendent of one of the leading lines of railway, and had had experience in the management and construction of steam engines for the last twenty years. He did not endorse the opinion of the owner, but pointed out that the safety-valve —the only one with which the boiler was fitted—was loaded with a spring balance, which, when screwed down to its ordinary pressure, viz., 45lbs., allowed but little room for the valve to lift, and as there was no ferrule or stop on the screw to keep the adjusting nut from being turned too far, the valve might easily have been locked fast by the attendant without his being aware of it. This the witness thought had most probably been the case, adding that though the stop ferrules were the rule on the spring balances of locomotive boilers, they were but too seldom applied to agricultural ones, while he recommended the general use of an efficient duplicate safety-valve and a steam-pressure gauge, which had not been adopted in the present instance.

There appears every reason to agree with the evidence given by the last witness and to conclude that the safety-valve had been locked fast as suggested. As the boiler was not fitted with any pressure gauge, the attendant was in the habit of slacking the thumb-screw which adjusted the spring balance, in order to ascertain at what point the steam blew off, according to the figures on the scale. He had done this but a short time before the explosion occurred, and screwed it down again as it was supposed to the ordinary working point of 45lbs. per square inch. Inasmuch, however, as there was but little margin below that point, he had, no doubt, inadvertently turned the nut a thread or so too far, and thus locked the spring fast, as others under similar circumstances have frequently done before him with equally fatal results. From the dangerous construction of the spring balance and the frequency of explosions from this cause, there seems no reason to doubt that such had been the case, and that the explosion may be attributed to accumulated pressure, in consequence of the defective arrangement of the safety-valve.

The jury took this view of the matter, and found that "the engine driver was killed by the explosion of a portable steam engine, caused, as far as could be gathered from the evidence, through the overscrewing of the safety-valve by the deceased himself."

It would be unfair to the boiler attendant to infer from this, however, that he was the victim of his own negligence. He was doubtless unaware that the safety of the boiler, as well as his own life, hung upon a single turn of a thumb screw. The makers should never have turned so deadly an instrument out upon the world, to kill innocent and well-meaning attendants. The boiler should have been fitted with a suitable gauge, to have shown the precise pressure of the steam, and the safety-valve, if loaded with a spring balance at all, should have been fitted with a stop ferrule or collar to have prevented its being overscrewed, while an efficient duplicate safety-valve should have been added to prevent any excessive pressure, even though the other had been deranged. The adoption of these recommendations in the present instance would doubtless have prevented the explosion and its fatal consequences under consideration.

No new portable engines should be fitted up without steam-pressure gauges and efficient duplicate safety-valves, say of dead-weight construction, while, if spring balances are adopted, they should all be fitted with stop-collars or ferrules. In boilers already in work, these safeguards could be added with but trifling expense.

No. 7 Explosion occurred on Tuesday, March 19th, at a farmstead, and resulted in the death of eight persons, as well as in injury to four others.

The boiler, which was of the portable multitubular agricultural type, and employed for driving thrashing machines, was rent on its explosion into two main fragments, the fire box with the flue tubes being separated from the barrel of the boiler, while, in addition, the plate forming the sides and top of the outer casing of the fire box was ripped off. These fragments were scattered right and left, one of them being thrown across the road into an adjoining field, to a distance of forty or fifty yards. Unfortunately the explosion occurred at dinner time, when the workpeople had clustered round the boiler for the warmth it afforded them on a cold day with a biting east wind, when just as they were taking their meal the boiler burst, scattering them on all sides, and injuring eight of them fatally.

The cause of the explosion appears from the evidence to have been of the simplest kind. The engine driver was seen shortly before the explosion to be working the boiler with the safety-valve lever tied down by a cord, so that as soon as the engine was stopped for the dinner hour the boiler burst from accumulated pressure. This view was supported by all the witnesses who gave evidence at the coroner's inquest, and the jury returned a verdict "that the deceased were accidentally killed by the explosion of an engine boiler, caused by improperly tying down the safety-valve."

It should be pointed out, however, that had the complement of fittings with which the boiler was equipped been as complete as it ought to have been, there is every ground to conclude that the explosion would have been prevented and the lives saved. From the fact of portable boilers being in the hands of farm labourers, the complement of fittings should be all the more efficient and the less liable to derangement, instead of which it is far inferior to that adopted in the general run of stationary boilers, though they are entrusted to more skilled attendants. In this case, as in the case of No. 6 Explosion just reported, the boiler had no steam pressure gauge or duplicate safety-valve. Had there been a steam gauge it would have indicated the excessive pressure, and had there been a duplicate safety-valve of suitable construction, the attendant could not have gagged it simply by a cord. It is not contended that any safety-valve can defy the attacks of skilled malice, that is clearly impossible; for anything that one man can make another can derange; but the safety-valves on portable engines are not exposed to the ingenuity with which a burglar attacks a safe or picks a lock, but simply to the negligence and stupidity of ignorant men, and there are many safety-valves that would meet this difficulty, at least to a considerable extent. At all events the best appliances should be fairly tried, and portable engines no longer allowed to work so inefficiently equipped that a careless man may make them as dangerous as a powder magazine, simply by tying the safety-valve lever down by a rope, or giving a thumb-screw on the spring balance an extra turn.

No. 9 Explosion, by which two persons were killed, occurred at half-past ten o'clock on the morning of Friday, March 29th, on the premises of a pork butcher.

The boiler, which was worked at a pressure of 20lbs. on the square inch, was of plain cylindrical externally-fired construction, the ends being flat, or nearly so, having a well of about half an inch, while the front one was attached by an external angle iron. The boiler measured but 4ft. 7in. in length by 2ft. 4in. in diameter, and was made of plates only $\frac{3}{16}$ths of an inch in thickness originally, while the external angle iron by which the front end plate was attached to the shell was $1\frac{5}{8}$in. × $1\frac{5}{8}$in. × $\frac{3}{16}$ths of an inch, the rivet holes in this ring being unevenly pitched, the distances varying from $1\frac{5}{8}$in. to 2in. There were no means of making an internal examination of this boiler, or of cleaning it out, or even of emptying it when in place, since there was no blow-out apparatus or emptying plug; neither was there any manhole further than a small opening on the top, which might be termed a handhole, so that the only way of cleaning out the boiler was to remove it from its seat, and treat it like a barrel, rolling it over so as to get the dirt out through the handhole as through a bunghole. The boiler had not been cleaned out since it had been re-set in the year 1863, but, fortunately, the town's water with which it was fed seems to have been pretty pure, so that the incrustation was only $\frac{1}{4}$in. thick along the bottom.

The boiler failed at the front end, which was blown out, being severed through the plate nearly all the way round close to its attachment to the external angle iron, and torn away from the rivets through the remainder of the rupture. The shell did not stir from its place, but the owner and his apprentice, working alongside, were scalded to death by the escape of steam and hot water.

An examination of the fragments left no doubt as to the cause of the explosion. A considerable portion of the front end plate had been reduced at the line of fracture to the thickness of a knife edge by a deep groove or furrow, which ran nearly round the boiler inside, and had eaten into the plate at the base of the external angle iron. This groove was caused by the corrosive tendency of the water, combined with the buckling action of the front end plate in consequence of its weak construction. It was also found, on removing a brick at the back of the right hand side flue, that the cylindrical shell was wasting at that part from external corrosion, and the inspector easily thrust a carving fork through the plate, which proved to be no thicker than a sheet of brown paper. The boiler altogether was unfit to be worked, and the explosion may be attributed simply to wasting of the plates from internal corrosion.

No. 11 Explosion occurred at a spinning mill, at two o'clock on the afternoon of Saturday, April 20th, and resulted in the death of one person, as well as in injury to two others.

The boiler, which was of plain cylindrical construction, and externally-fired, was of very diminutive size, measuring only about 6ft. in length by 2ft. 5in. in diameter, and being made of plates $\frac{1}{4}$in. in thickness throughout. The front end plate was domed 3in., while the back was perfectly flat and attached to the shell by an angle iron $2\frac{1}{4}$in. × $2\frac{1}{4}$in. × $\frac{1}{4}$in., and a longitudinal bolt stay made in two lengths, and connected together by cotters, ran from end to end.

The boiler gave way at the back through the line of rivets in the angle iron connecting the flat end plate to the shell, the rupture extending round the entire circumference, while at the same time the longitudinal bolt stay was torn asunder in the middle at the cotters. The engine connected to the boiler was shattered to pieces, while the main part of the shell penetrated through two brick walls, doing considerable damage in its course, and it is reported that the amount of destruction caused by this boiler is almost incredible, considering its small size.

With regard to the cause of the explosion, it appears that the boiler was too small for its work, and could only keep the engine running for a short time before coming to a standstill, and therefore to meet this difficulty the steam used to be bottled up at as high a pressure as possible before starting. The boiler was fitted with one safety-valve, $1\frac{1}{16}$in. in diameter, enclosed in a box, and in order to raise the pressure more effectually, the foreman mechanic, who certainly should have known better, screwed an iron plug into the safety-valve discharge pipe, thus rendering the escape from the valve impossible, and virtually doing away with it altogether. The result is not difficult to foresee. The engine was allowed to stand in order to get up the steam, when the pressure was seen by the gauge to rise to 90lbs. on the square inch, and just as the fly-wheel was being turned round to start the engine, the boiler burst, so that this explosion may be attributed simply to excessive pressure of steam, caused by the attendant's tampering with the safety-valve.

No. 14 Explosion, by which three persons were injured, occurred at seven o'clock on the morning of Saturday, May 18th, at a plaster mill.

The boiler, which was worked at a pressure of 60lbs. on the square inch, was of the plain Cornish class, being internally-fired, and having a single furnace tube running from end to end. Its length was 20ft., its diameter in the shell 5ft. 11in., and in the furnace tube 2ft. 10in., the thickness of the plates in the shell being $\frac{3}{8}$in., and in the furnace tube $\frac{3}{8}$in. in some places, and $\frac{5}{16}$in. in others, while the first crown plate was in some parts little more than $\frac{1}{4}$in. The front end plate was attached to the shell by an external angle iron, measuring $2\frac{1}{2}$in. by $2\frac{1}{2}$in. by $\frac{7}{16}$in., while the other angle irons measured $2\frac{1}{4}$in. by $2\frac{1}{4}$in. by $\frac{3}{8}$in. The flat end plates were not strengthened, as in the most approved modern boilers, with substantial gussets, but with diagonal stays 3in. wide by $\frac{1}{2}$in. thick, fastened at the end by a single bolt $\frac{5}{8}$in. in diameter.

The boiler gave way at the internal furnace tube, which collapsed vertically

from end to end, tearing away all round at the furnace mouth angle iron, as well as at the back end for a length of about 8in. at the crown; in addition to which the tube severed at two of the ring seams of rivets, and thus divided into three pieces, while the diagonal stays pulled out at the bolt holes, and both end plates rent from the shell, the back remaining intact, with about a third part of the furnace tube attached to it, the front being divided into several pieces. These fragments were thrown in every direction, while the boiler-house and surrounding buildings were levelled, and the boiler shell thrown forward about 33ft., carrying away a massive beam in its course, and afterwards passing through a brick wall. Great as was the havoc, fortunately no one was killed, but three persons were seriously injured by the *débris*, two of them being buried in the ruins.

There can be no doubt as to the cause of this explosion. The furnace tube was not strong enough for the pressure it had to sustain. It shows most careless workmanship to have constructed the tube of such different thicknesses of plates as those mentioned above, while the mode of staying the flat ends was paltry and second-rate. The furnace tube was not strengthened as it should have been with flanged seams, encircling hoops, water pockets, or other approved means, and had these been suitably applied the collapse would have been prevented. Without these appliances no boiler should now be constructed to work at so high a pressure as 60lbs. on the square inch. This boiler, which was only about a year old, was a perfect disgrace to the man that made it, and it is to the weakness of the furnace tube through malconstruction that this explosion is solely due.

Before concluding this report, attention may be drawn to the diminutive size of three of the boilers, the explosions of which are recorded above. In No. 9, the boiler was only 4ft. 7in. long by 2ft. 4in. in diameter; in No. 11, 6ft. long by 2ft. 5in. in diameter; in No. 13, 3ft. 2in. long by 1ft. 8in. in diameter. Yet, small as these boilers were, three persons were killed, and four others injured by them. There appears to be a very general impression that the explosion of small boilers is not attended with fatal consequences. This has been referred to in previous reports, and it will be remembered that a boiler that burst on the 9th of October, 1866, and was reported under the head of No. 49 Explosion in last year's Report,* was but 5ft. 6in. high and 2ft. 6in. in diameter, while there was no brickwork surrounding it, yet it killed eight persons. Small boilers are, to a certain extent, more liable to explosion than large ones, inasmuch as they are considered not worthy of the same amount of attention, or as full a complement of fittings. The facts given above will, it is trusted, tend to dispel the erroneous ideas entertained with regard to the danger of these small boilers, and secure for them the attention they deserve.

INSTITUTION OF MECHANICAL ENGINEERS.

MEETING IN PARIS, JUNE 4th.

ON THE VENTILATION OF PUBLIC BUILDINGS.

BY GENERAL MORIN.

The renewal of air in buildings is only rendered necessary by the vitiation resulting from the respiration and exhalations of the occupants, and by the accumulation of the products of combustion from artificial lighting; and the writer has been led, by his own observations and the consideration of the results obtained by others, to the following conclusions as to the principles on which the ventilation of buildings should be based:—

1st. Ventilation consists in getting rid of all vitiated air and replacing it by fresh air.

2nd. The principal object of ventilation is to get rid at once of all vitiated air. It ought to be removed in general from the point nearest to the place where the air is vitiated, in order to prevent any further diffusion into the room; and, on the contrary, fresh air ought to be introduced at the point farthest removed from the occupants of the room.

3rd. The different arrangements for ventilation by suction, well proportioned and well carried out, are more effectual than those which depend exclusively on blowing in the fresh air, as the latter do not in every instance and at all times ensure the vitiated air being uniformly and continuously expelled.

4th. The quantity of fresh air required, whatever may be the height from which it has to be drawn, and whatever the quantity, can be obtained by suction alone, and without the aid of any blowing apparatus, by giving to the inlet openings for fresh air sufficiently large dimensions, and by suitable arrangement.

5th. Suction can easily be obtained either by means of the ordinary open fireplaces with chimneys or similar heating apparatus, or by means of special fireplaces placed at the bottom of the exhausting-flues and acting as auxiliaries when the rooms are large. The air to be removed ought to flow towards the bottom of these fireplaces, and, wherever possible, by means of special air-flues leading from openings close to the sources of vitiation.

6th. Ventilation by suction by means of fireplaces and chimneys can be adapted to the proportions and arrangements of every kind of room, as it resembles the ordinary and natural ventilation of rooms, and the volume and temperature of the fresh air supplied can be varied as required. It only requires the construction, at a small expense, of fireplaces with their chimneys and of air-flues, which, when once constructed, cost but little to keep up: and also the regular feeding of the fireplaces, which any common attendant is competent to do. On the contrary, ventilation by means of blowing or other mechanical apparatus necessitates, beside the flues and chimneys common to both systems, the addition of blowing machines and engines with special air passages, special artizans, engineers, and firemen, and involves an extra cost for keeping up.

7th. In hospitals with several stories, the blowing-in system does not afford the same guarantee as that of suction against the diffusion of the vitiated air from one room to another through the opening of the discharge-flues, when it happens that the pressure and movement of the air of the room is disturbed by the opening of doors and windows.

Suction produced by simple fireplaces and chimneys, with sufficient area of opening for allowing the fresh air to replace the vitiated air, and without any mechanical apparatus, is consequently the most desirable means, in the writer's opinion, for effecting the ventilation of buildings, except in rare cases; and where special circumstances may necessitate the forcing-in of fresh air by mechanical means, the action of a strong suction should also be added. This necessity never occurs in buildings where a continuous supply and removal of a nearly uniform quantity of air is required, but only when, on the contrary, the service has to be varied frequently between different portions of the same building, and when the quantities of air to be removed differ greatly from one day or from one hour to another, as in the case of St. George's Hall, Liverpool, where mechanical ventilation exclusively is adopted, and the quantity of air required varies in the extreme proportion of 1 to 50. In such cases it may become necessary, or at least useful, to employ mechanical apparatus in addition to the action of suction, in order to ensure a sufficient supply of fresh air.

The following proportions for the quantity of air required to be supplied per hour for each person are based upon the results of a large number of experiments by different observers, and, though higher than the rates formerly adopted, are not in the writer's opinion at all exaggerated:

Hospitals for ordinary patients	2,000 to 2,400	cubic feet.
Ditto, in cases of epidemic	5,000	,,
Workshops, ordinary trades	2,000	,,
Ditto, unhealthy trades	3,500	,,
Prisons	1,700	,,
Theatres	1,400 ,, 1,700	,,
Meeting-halls..................................	1,000 ,, 2,000	,,
Schools for Children......................	400 ,, 500	,,
Ditto, Adults	800 ,, 1,000	,,

The temperature of the atmosphere in places abundantly ventilated, and having a continuous renewal of the air, can be allowed to be maintained at a higher point than in rooms not well ventilated; but as a general rule the temperature should not exceed, in

Hospitals...	61° to 64°	Fahr.
Workshops, barracks, and prisons	59°	,,
Schools...	66° ,, 68°	,,
Meeting-rooms	66° ,, 72°	,,
Theatres	68° ,, 72°	,,

The fresh air supplied should be at nearly the same temperature as the one to be maintained in the room; but this has to be increased to as high as 85° or 95° Fahr., if there is a large cooling surface of glass; or to be diminished where the room is heated by a large number of lights or a large concourse of persons. For the purpose of regulating the temperature, the supplied air, warmed by some heating apparatus, has to be received first into a chamber into which cold air can be introduced for mixing with it.

The following relations between the volume and temperature of the air and the areas of the air flues have been obtained from theory and practice combined:

$$V=C\sqrt{(T-T^1)H}$$
$$Q=CA\sqrt{(T-T^1)H},$$

in which A = sectional area of the exhausting flue.
H = height of exhausting flue.
T = average temperature of air in flue.
T^1 = temperature of external air.
C = co-efficient, constant for each air-flue as regards its proportions and arrangement.
V = average velocity of air in the flue.
Q = volume of air passed per second.

The results derived these relations are that the velocity of the escaping current is proportional to the square root of the excess of the temperature of the heated air in the flue over the external air, and also to the square root of the height of the flue or chimney; and the volume of air extracted is consequently proportional in addition to the sectional area of the flue.

The position of the openings for the admission and removal of the air is a point of great importance; and none of these should be made at the level of the floor, as is too often the case, because they are then exposed to obstruction by sweepings and rubbish from the floor. The openings for the admission of fresh air, whether warm or cold, should be placed near the ceiling, or at such a height that no person may receive the impression of a draught. The openings for the abstraction of the air should, on the contrary, be placed generally in the lower part of the room.

The velocity of the air should continuously increase through the several passages of the building, from its entrance to its final discharge, which is best effected by the use of a single shaft for taking off the air from the whole building; and the velocities should be about—

2·3 to 2·9ft. per second at the entrance.
3·3 ,, 3·9 ,, ,, in the first passage.
4·3 ,, 4·6 ,, ,, in the second passage.
5·9 ,, 6·6 ,, ,, in the discharging shaft.

These speeds can be easily obtained in most cases by an excess of 35° to 45° in the temperature of the discharging shaft over the external air, except in the

* See the ARTIZAN for February, 1867, page 38.

case of theatres, where a difference of 95° to 105° is required, on account of the complication of the passages. With the supply openings in the ceiling, so that the air descends vertically, the velocity of the entering current should not exceed 1·6ft. per second; but when the air enters at the sides of the room at a considerable height, the velocity may be as high as 3·3ft. per second, without causing inconvenience. The plan of ventilation by suction has been objected to as causing objectionable draughts of air when doors are opened communicating with the exterior; but this sensation of draughts is got rid of, when suitable proportions are adopted, and when care is taken that the passages communicating with the exterior are suitably warmed. The ordinary chimneys of houses produce in many cases a sufficient abstraction of air even without a fire, from the ordinary difference of temperature between the internal and external air; and this ventilating power can easily be increased by introducing into the chimney a vertical pipe containing a few gas-burners.

ON FLOATING DOCKS.

By Mr. FREDERICK J. BRAMWELL.

For the purpose of affording access to the immersed parts of vessels, there can be little doubt that in the early periods of navigation the vessels were either hauled up on the beach for examination, in the absence of rise and fall of tide; or, where there was a considerable rise and fall of tide, the vessel was placed over a flat beach at high water, and allowed to ground as the tide fell. Although the latter plan is easy of application, and useful, to a certain extent, even for large vessels, where there is a considerable rise and fall of tide, the former mode must have been difficult to carry out except with very small vessels; and, therefore, it is probable that the plan of "careening" was resorted to as soon as vessels were built of any considerable size.

This plan, more properly called "heaving down," was carried out in two ways: either by bringing the vessel near a quay-wall provided with mooring-rings and capstan, and attaching ropes to the heads of the masts, so as to haul the ship into a nearly horizontal position on the water; or by putting the heaving-down tackle on board another vessel, so that the operation could be performed independently of the land. This second plan had the advantage of being also independent of the rise and fall of the tide, which, in the other method, of course affected the position of the ship under repair.

The plan of "careening" seems to have been extensively practised in the naval arsenals of France at an early date. Whether done by tackle from the land or from a ship afloat, the operation was of course aided by the removal of the ballast and heavy weights, so as to lighten the vessel. By the mere shifting of the weights, and without the assistance of tackle, a large amount of the ship's surface could be exposed; but this plan was of necessity attended with considerable danger of foundering, as exemplified in the fate of the *Royal George*, which foundered at Spithead in August, 1782, with upwards of 600 persons on board, whilst being careened. Careening is also stated to have been the cause of permanent distortion in the shape of vessels, from the exposed side being strained to an unnatural degree of convexity prior to the driving in of the caulking, which then kept the vessel to the distorted figure it had assumed.

The next mode to be mentioned is the ordinary graving dock or dry dock, which even at the present day is the plan most commonly employed in Europe, and will probably continue to be preferred in all places where there is a large rise and fall of tide, and where the soil is suitable for excavation. As regards the derivation of the term "graving" dock, it has been suggested that the name was taken from the resemblance which the dock bore to a "grave;" but the writer believes it to be derived from the operation carried on in the dock, as it appears from records of the date 1667 that what is now called "paying" a vessel with a composition was formerly called "graving;" and it would seem that this word is of French origin, and in turn owes its derivation to the place where the graving was sometimes performed, namely, on a flat sandy beach or *grève*. As early as 1623 there was a dry dock at Deptford, and in 1667 there was one also at the arsenal of Rochefort in France.

Various kinds of graving-docks have been either executed or proposed. In many parts of England the rise and fall of the tide are sufficient to admit of very large vessels being drawn into a dock at high water, brought over the keel blocks, and allowed to settle down upon them as the tide recedes, until the dock is left dry and the vessel exposed for repairs; the sluices being then closed exclude the water, so that the succeeding tides cause no interruption to the work. But in situations like the shores of the Mediterranean, and in other places where the tide is but small, the water has to be got out of the dock by pumping, which, before the days of steam power, was found both an expensive and a tedious process, causing great delay before the vessel could be reached even for slight repairs, or even for inspection. To make the operation more expeditious, large chambers have in some instances been provided below the level of the dock, sufficiently capacious to receive from the dock the whole or the greater part of the water contained in it, which could afterwards be pumped out of them at leisure. This plan certainly gave the advantage of speed in emptying the dock, but it added largely to the first cost, and, moreover, caused the labour of pumping to be increased, owing to the greater depth from which the water had to be drawn; nevertheless, these chambers were in use at Toulon and also at Portsmouth, notwithstanding that at the latter port there is a rise and fall of about 10ft. at ordinary spring tides.

In some few favourable situations graving docks are comparatively simple to construct and maintain, namely, in such situations as Birkenhead, where the docks are hewn out of the solid rock, which, while it is sufficiently hard and homogeneous to support the heavy weights, is sufficiently soft to be readily worked. In these cases there are none of the dangers to be apprehended of settlement or of blowing up the bottom that exist where the dock is built in an excavation made in the earth, which is frequently of an extremely treacherous character at river sides. As regards the mode of closing the entrance to dry docks, this has been effected either by gates, to open sideways like those of a lock, or to fall upon the bed of the river, or by caissons. The latter, now that the introduction of iron for shipbuilding purposes has admitted of their being made of that material, are almost universally adopted for large docks and have the advantage of affording the means of retaining water inside the dock as well as of keeping it out, which is of considerable importance for allowing time enough to adjust the vessel properly before it settles down on the keel blocks. Among the largest graving docks may be mentioned the double dock now constructing at Brest, 721ft. long and 92ft. wide, with 55ft. depth of water over the cill; and the double dock at Portsmouth, which is 636ft. long, 88ft. wide, and 27ft. deep over the cill; and one of the largest single docks is that of Malta, which is 415ft. long, 73ft. wide, and 32ft. deep over the cill.

The hauling-up of ships appears to have been practised from a very early period in the Venetian arsenals, and also at Toulon, in France, where it was carried out in 1818 on a large vessel; but the ships seem to have been only brought over an ordinary building slip, and then hauled up on the ways, being steadied by a sort of sliding cradle.

A special construction of carriage for this purpose was invented in 1818 by Mr. Morton, of Leith. An inclined-slip way is formed on a slope of about 1 in 20, and provided with rails on which travels a wheeled carriage, the railway being extended sufficiently below the water to admit of the ship being floated over the carriage. By then hauling up the carriage by the chains and capstan gear, the ship being attached to the chain is drawn up out of the water and above the influence of the highest tide, and is blocked up off the floor of the slip, so as to admit of the carriage being removed. To prevent the ship from heeling over, the carriage is provided with bilge blocks, sliding on timbers transverse to the slip. As the vessel settles down on the keel blocks, and before she is removed from the water, the bilge blocks are hauled in until they support the bilges, the hauling being done by ropes led up to the deck of the ship. This appears to have been the first use of proper bilge-block shores which could be applied while the vessel was still afloat, and in the writer's opinion such a mode of sustaining vessels at the bilges before the water support is taken away, is of the greatest utility, on account of its importance in preventing undue straining or risk of heeling over. In ordinary graving docks, it is true, bilge shores are used, but they are not applied until the water has been removed from the dock, and therefore not until after the ship has been subjected to the strains arising from the weight of her contents without her natural water support.

Morton's slips were at first intended only for small vessels, but they have lately been constructed for ships of 2,000 to 3,000 tons burden. With small vessels little difficulty was experienced in building the slips, especially where there was a considerable rise and fall of tide, because the lower part of the slip could be constructed at low water; but when the longer modern vessels were required to be taken up, the length of the slip-way below the water became very great, as a slope of 1 in 20 requires the length of slip below water to be twenty times the draft of the vessel merely to reach her stem, and the slip must then be carried still further to extend under the length of the vessel. As this portion had to be constructed by the aid of divers, and its execution was attended with serious difficulty, it has been proposed to shorten the slip in three ways. The first plan is to make the slip of a curved form, so that the part below the water line is much more nearly horizontal than if the slope had been uniform; the second mode, intended for places where there is a rise and fall of the tide, is to enclose the upper part of the slip within water-tight walls, and employ gates for shutting out the water; and the third plan is a telescopic construction of the cradle on which the ship is lifted.

The application of the slip to vessels of a larger class soon rendered some improvement necessary in the simple hauling chain that had sufficed for ships of 200 tons. A set of traction rods was first substituted for the body of the chain, and was hauled in by a short flat-linked chain working over a pitched wheel driven by gearing. The end of this flat chain was first attached to the foremost rod, and then hauled in until the second rod was brought up to the place of the first, when the flat chain was overhauled and made fast to the second rod; and this operation was repeated with the successive traction rods until the ship was fairly drawn up. A further improvement consisted in making the flat-linked chain endless, so as to avoid the necessity of over-hauling it. For some time past, however, the larger slips that have been erected have been worked by the direct application of hydraulic rams to the ends of the traction rods; and, among other plans, double presses have been employed, made to work alternately, so that the hauling-up might be nearly continuous.

An important adjunct to the slip is an arrangement of transverse lines of rails in the building-yard at the upper end of the slip, so that by the use of carriages the vessels hauled up can be shifted sideways, thereby enabling a single slip to serve for hauling up several vessels requiring repairs at the same time.

The simple plan already mentioned of placing a ship on a beach at high water, so that it may be left dry at the ebb, is still used where there is a considerable rise and fall of tide; and, to enable it to be carried out without risk of unequal support to the ship, a regular open framing of beams is made on the beach, called a "gridiron," by means of which vessels can be blocked up, and properly examined and repaired at low water. There is, of course, the objection that at the rise of each tide the work has to be suspended; but nevertheless the system is so simple and inexpensive, and the vessels are so readily got off and on, that it still continues to be used.

In each of the various plans already considered, with the single exception of careening by the aid of another vessel, it has been necessary that there should be some connection with the solid ground; but floating docks properly so called dispense with the necessity of any such connection with the land for the purpose of support, as the dependence for support is on the water alone, the only re

quirements being a sufficient depth of water and a holding ground to which the apparatus can be anchored.

As early as 1785 a floating dock was constructed by a shipbuilder named Watson. It consisted of a timber vessel, 245ft. long, 58ft. wide, and 23ft. deep on the blocks, having an open end which could be closed by gates. Water being admitted into the vessel to sink it to a sufficient depth, the gates were opened, the ship to be repaired was drawn in, and then the gates being closed and the sluices shut, the water was pumped out, leaving the ship in the interior of a true floating dry dock. Mention is made of one vessel, the *Mercury*, having been docked in this dock with great success. No provision appears to have been made to regulate the descent of the dock, nor to prevent it from sinking too low, and it is to be assumed that the material employed being wood was in itself sufficient for this purpose. Docks of a similar character have been constructed at various times and places; but in order to ensure stability they have been sunk between guiding piles upon a level bed, and were, therefore, not true floating docks, that is, docks independent of the land. Such a dock, it appears, was proposed to be constructed for the port of Havre, about 1848.

In 1809 Trevithick and Dickinson designed a floating dock or caisson of wrought iron, with air chambers at the sides for floating the dock when its body was full of water. It was then to be sunk by admitting just as much water into the air chambers as was required for making it very slightly in excess of the specific gravity of the water; and the ship being brought over it, the caisson was to be raised by ropes until its top edge was brought just above the surface; and then the water was to be pumped out of the body of the dock, so as to make the caisson rise all round the ship, leaving the ship accessible for repair. The size of caisson proposed was 220ft. long, 54ft. wide inside, and 30ft. deep, the top being surrounded by a flat rim 6ft. wide to serve as a working platform, and also to strengthen the edge. The record of this idea appears to possess considerable interest, as showing that even so early as 1809 the possibility of constructing a wrought iron caisson of these large dimensions was contemplated.

The Sectional Dock was invented in the United States about 1837. It consists of a certain number of sections, each composed of a bottom caisson, and raised frames carrying platforms and houses on the ends of the caissons. The frames are made high enough for the greatest depth to which the dock has to be sunk, so that the platforms and houses may at all times be out of the water. Air tanks are so placed in the frames as to be capable of movement within these, or rather the frames are capable of movement past the tanks, as the latter remain without much variation in reference to the level of the water in which the dock is floating. The connection between the tanks and frames is made by means of rack and pinion gearing, worked off shafting which extends along the dock from the engines in the houses on the central sections. The pumps are connected with the bottom caisson and worked by the same shafting. In applying this dock for lifting a vessel, a number of the sections are brought together and secured to one another by the beams; and sluice valves being opened to admit water into the caisson, the dock begins to sink. The gearing connected with the air tanks is then put to work, so as to allow the tanks to remain at the surface of the water while the dock sinks to the desired depth, at which it is then held suspended by the air tanks. The sluice cocks are then shut, and the vessel is drawn into the dock and secured in a central position by "breast shores." The pumps are then all put to work to raise the dock until the vessel takes the keel blocks, when the bilge blocks are hauled in to support her, and the pumping is continued, causing the dock to rise, lifting the vessel with it. In the act of rising the whole is in a state of unstable equilibrium, and would be liable to turn over were it not for the air tanks, which, by means of the gearing, are still kept at the water level. By this arrangement, if the dock endeavour to heel over, it is at once restrained by the air-tanks, as it cannot change its perpendicular position without drawing one of them partially into the water, and raising the opposite one an equal amount out of the water. Thus, if due precautions as to the bulkheads be taken in the construction of the dock, to prevent an excessive force from being applied to turn the dock over, the side air-tanks are sufficient, not merely for determining the points to which the dock shall sink, but also for giving it stability both in rising and sinking. These sectional docks have been connected with a system of railway, so that a vessel might be run off the dock on to the rails and repaired there, while the dock was used to lift another vessel.

The Balance Dock or Box Dock, introduced in the United States in 1839, consists essentially of a pontoon bottom with two side walls. The pontoon possesses sufficient displacement to carry the whole weight of the dock and of any ordinary vessel that has to be raised. The side walls are hollow and of considerable width, serving the same purpose as the air tanks in the sectional dock, namely, to prevent the dock from sinking too far and to preserve its stability in rising and sinking. Portholes are made in these walls to assist ventilation, and the walls afford the means of shoring up the ship by breast shores as in a stone dock; on the top are the engine-house and pumps and the working plate form. For lifting the heaviest vessel that could be taken inside the dock, gates have been fitted at the ends of the dock, so that it might float with the surface of the pontoon below the water and thus acquire an additional amount of buoyant power according to the depth of immersion.

Several balance docks have been constructed in America, which the writer believes have all been built of wood. The dock at Havannah was built at New Orleans in 1858, and was towed out without accident to Havannah. It is 300ft. long by 79ft. broad, and the hollow floor is 9ft. 6in. deep, and it can lift a vessel of 20ft. draught. It is provided with one steam engine, having a cylinder 12in. diameter and 30in. stroke, working with 60lb. steam, and driving seven pumps with barrels 24in. diameter and 30in. stroke, making about 14 double strokes per minute. Being constructed of wood, with a solid thickness of 2ft. 6in. of timber in the flooring, the floating power of this dock is so great, that for sinking it not only has all the available space to be filled with water, but 500 tons of ballast have to be added. The total cost of this dock was £100,000.

In considering the essential principles of a good floating dock, and the defects most important to be guarded against, the first and principal requirement appears to the writer to be that the ship should be supported on as rigid a bottom as when on a building slip or in a stone dry dock. This condition, however, is not universally recognised, but, on the contrary, it is urged that, if a vessel has assumed a certain distorted form in the water, this form ought to be retained when out of the water for purposes of repair; and it is alleged that this can be accomplished by giving the ship an elastic bearing, such as that afforded by the separate portions of the sectional dock, or by the somewhat yielding saucer of the Thames graving-dock. The employment of an elastic bearing appears to the writer, however, to be erroneous, because it is based on the assumption, either that the ship, having already gone out of shape to a certain extent, will not yield further, or that all the parts of a vessel are of equal weight per foot run, so that the elastic bearing will yield to an equal extent at all parts throughout the entire length of the vessel, which is evidently contrary to fact.

The other requirements of a floating dock are stability, ventilation, facility for repair of the dock itself, and a minimum expenditure of power and time in lifting the dock. The materials employed should also be arranged in such a manner as to obtain a maximum of strength from a minimum of material; and the design should be one admitting of many repetitions of a few forms, so as to allow of the work being done to a few standard templates, avoiding, as far as possible, any necessity for welding heats and smith's work.

The foregoing principles were kept in view by the writer on the occasion of his having to design a floating dock for the Danish Island of St. Thomas, in the West Indies. This dock has been prepared in England, and is now in course of erection at St. Thomas. The leading particulars are as follows: length, 305ft.; external width, 100ft.; clear width between the side girders, 72ft.; depth of bottom, 9ft. 9in.; extreme height, 42ft. 3in.; it can take in and lift, leaving an adequate amount of free board, a vessel drawing 24ft. of water and not exceeding 4,000 tons of actual weight, not tonnage. The weight of the dock, with machinery and all complete, is about 3,400 tons.

There are two main girders and six watertight pontoons, forming the bottom of the dock. These have "set downs" at the ends, where they receive the bottoms of the main side girders; and as any one pontoon may have either to support the girders or to be partially supported by them, the connection has been made by means of very strong attachments rivetted to the pontoons and having shanks extended down to the very bottom of them. Cross plates are placed over the diagonals of the main girders, near the junction of the diagonals with the uprights; and on these plates bear strong cotters, so that if one of the pontoons were quite full of water, it could be lifted by the others without the least injury. The attachment of the pontoons to the girders is one which can at any time be readily undone, so that any pontoon can be detached and floated away, and then taken up on the remaining pontoons for examination and repair.

In designing the construction of the St. Thomas floating dock, the object of the writer was to supersede the objections that appear to him to attach to the Morton slip and other ship lifts. The reason for discarding the use of slips and lifts was that they are dependent on the earth for their support. This objection, however, did not apply to the sectional or the balance dock, both of which, like the St. Thomas's dock, have the important advantage of being wholly independent of the land, and are therefore capable of use in any place where there is sufficient shelter and depth of water, combined with the means of mooring. The grave objection in the writer's opinion to the sectional dock is its entire want of rigidity. Although this does not apply to the balance dock, yet this dock also involves objections which the writer believes to be of importance. One is that, as ordinarily built in one entire structure, the balance dock requires either an excavation into which water can be admitted to float the dock after its completion, or else the construction of very large and expensive launching ways. Moreover, the rigidity and also the stability are obtained by the use of complete side walls, which have a large displacement when the dock is sunk. As far as the question of rigidity is concerned, the writer believes that these side walls involve the use of more iron than is required in an open girder to obtain the same strength; while they absolutely preclude efficient ventilation of the sides of the ship, and prevent a large extent of surface for reflecting the heat of the sun and for the wind to act upon. The engine power for pumping out the water is also increased as compared with open sides by the greater displacement of the solid sides when sunk, which involves a corresponding increase in the quantity of water to be taken in and subsequently pumped out.

In the St. Thomas's dock, although the lower part is composed of six separate pontoons, for facility both of original construction and of subsequent examination and repair, the objection applying to the sectional dock is got over by the use of the strong side girders. These are provided with a double set of diagonals, and have their top and bottom members made of such strength as to be capable of resisting a strain tending to depress either the middle or the ends. Thus, supposing the dock is in the act of raising a paddle-wheel steamer, which has a large portion of its weight accumulated in the centre, and only a small portion at the ends, the girders will transmit the surplus floating power of the end pontoons to the assistance of the heavily loaded central pontoons; and in the event of two small but heavy vessels being taken on at the ends of the dock, the girders will convey the extra flotation of the central pontoons to those at the extremities of the dock.

As regards the important question of stability and the means of controlling it, it is to be observed that even with the balance dock there is nothing to fear as long as the upper surface of the bottom is fairly above the water, because on any attempt at heeling over, the rectangular bottom produces a change in the position of the centre of buoyancy so rapid compared with any slight inclination of the dock, that the tendency to right itself is very strong indeed. Moreover, at that time the dock is pumped dry, and the danger arising from shifting the centre of gravity of the internal water is at an end. Besides, there is at this time within the dock a large amount of water, the centre of gravity of which is, of course, shifted by the heeling over; and the effect of this is most serious, unless a sufficient number of bulkheads is provided to

subdivide it into small sections. From whatever cause however the stability of a balance dock may have been disturbed, it is clear that the effort of its sides to restore equilibrium can be increased only in proportion to the amount of heeling over, and can never be caused to exert any effect in excess of this. If, therefore, a balance dock has once heeled over, it cannot be righted by its sides, so long as the force which caused the heeling over is continued.

With the side floats, however, in the St. Thomas's dock the case is different, as the position of the floats in reference to the dock can be controlled as desired; and therefore, in the case of any heeling over, an extra immersion can immediately be given to the floats on the low side, while those on the high side can at the same time be raised more out of the water. By this means, when the heeling over is only slight and therefore the tendency to heel over further is also slight, the floats can be made to exert as great a counteracting power as the walls of the balance dock would have, when the heeling over was great and therefore the tendency to go further also proportionately increased.

Another important reason for preferring the open sides of the St. Thomas's dock to the close sides of the balance dock was the saving of time in pumping for raising the dock. Supposing that the St. Thomas's dock had been made with close sides, these would have had each a sectional area of 14ft. wide by 25ft. deep when fully immersed, which with 300ft. length would give 210,000 cubic feet total displacement for the two sides. The section of the bottom is equal to 900 square feet, which, with 300ft. length, gives 270,000 cubic feet, or 7,700 tons; but as the dock, with all its machinery complete, weighs 3,400 tons, only 4,300 tons of water have to run in, equal to 150,500 cubic feet. Hence the close sides would have added $\frac{7}{5}$ ths to the amount of water to be pumped out; so that the time required for pumping out the dock, if the box sides had been used, would have been in the ratio of 36 to 15, or 12 to 5, as compared with the open sides.

In respect, therefore, to the three questions of ventilation, stability, and economy of pumping, the writer trusts that he has shown satisfactory reasons for preferring the open lattice girder with moveable floats to the close box side-walls of a balance dock.

ROYAL INSTITUTION OF GREAT BRITAIN.

ON THE WATER SUPPLY OF THE METROPOLIS.

By Edward Frankland, Esq., F.R.S., Professor of Chemistry, R.I.

Present Metropolitan Water Supply.—London is at present supplied with water by nine companies, who deliver about 108,000,000 gallons daily. Some idea may be formed of the vastness of this supply by a comparison of its volume with some well-known magnitude. If it were contained in a reservoir having a floor area equal to that of Westminster Hall, the walls would require to be carried to the height of 1,070ft., or more than three times the height of the Victoria tower, to enable it to contain the water which is daily distributed in the metropolis. Five of the water companies abstract about one-half of the total supply from the Thames; two withdraw about 42,000,000 gallons from the river Lea, and the remainder is pumped by two other companies (the Kent and South Essex Companies) from artesian wells sunk into the chalk of the Thames basin. Such is the present volume of water daily supplied to London and its suburbs; what will be the amount required twenty years hence it is difficult to estimate, but if the annual rate of increase since 1850 be continued, it can scarcely be less than 150,000,000 gallons, for in 1850 the gross daily quantity delivered was only 44½ millions of gallons, in 1856 it had reached 81 millions of gallons, whilst in 1865 it was 108 millions of gallons.

Proposed Water Supply of London.—Notwithstanding the best efforts of the water companies, the present supply of water to the metropolis is far from satisfactory, owing to causes which are mostly beyond the control of those to whom that supply is entrusted; it is therefore contemplated either to change entirely the source of supply, and thus obtain water of greater purity than any available in the neighbourhood of London, or so to alter the conditions at present affecting Thames water, as to materially improve its quality. For this purpose no less than five schemes have been recently brought forward, viz.:—

1. Sources of the Severn, proposed by Mr. Bateman.
2. The Cumberland Lakes—Messrs. Hemans and Hassard.
3. Thames water filtered through Bagshot Sands—Mr. Telford Macneill.
4. Storage reservoirs near the sources of the Thames—Mr. Bailey Denton.
5. Derbyshire and Staffordshire hills—Mr. Remington.

The last three of these schemes have scarcely yet assumed a shape for discussion from a chemical point of view; we shall therefore confine our attention to the first two.

Mr. Bateman's Scheme.—Mr. Bateman proposes to obtain the metropolitan water supply from the mountain ranges of Cader Idris and Plynlimmon, in North Wales, which constitute the chief sources of the Severn. These mountains rear their heads into the moist air brought from the Atlantic by the prevailing south-westerly winds, and receive the precipitation of from 70 to 150 inches of rain per annum. We should thus avail ourselves of a great natural and very active distillatory apparatus, furnishing water of great purity. These Welsh hills consist of the Upper and Lower Silurian formations, "which yield water as pure in quality as that of Loch Katrine, and which afford sites for magnificent reservoirs, which may be constructed with perfect safety and facility, and of sufficient capacity to economise the full annual rainfall I have assumed, and to last out droughts of from 140 to 150 days' duration, both for town supply and river compensation. One of these districts, of 66,000 acres in area, is situated a little to the east of the range of mountains of which Cadar Idris and Aran Mowddy are the highest summits, forming the drainage grounds of the rivers Banw and Vyrnwy. The other district, of about equal area, is situated immediately to the east of Plynlimmon, 2,500ft. in height. The discharge pipes of the lowest reservoir in each of these districts will be placed at an elevation of about 450ft. above the level of Trinity high-water mark. The water will be conducted by separate aqueducts, of 19 miles and 21½ miles in length respectively, to a point of junction near Martin Mere, from whence the joint volume of the water will be conveyed by a common aqueduct to the high land near Stanmore, where extensive service reservoirs must be constructed, which will be at an elevation of at least 250ft. above Trinity high-water mark. From these reservoirs the water will be delivered to the city at high-pressure, and under the constant supply system. The total distance from the reservoirs on the Severn to London will be 183 miles. One of the reservoirs on the river Vyrnwy will, by an embankment of 76ft. in height, form a lake of five miles in length, and will contain 1,089,000,000 cubic feet. Another, on the river Banw, by an embankment of 80ft. in height, will form a lake of four miles in length, and contain 940,000,000 cubic feet: and a third, in the same district, by an embankment of similar height, will contain 732,000,000 cubic feet. Amongst the reservoirs on the Severn will be one which, by an embankment of 75ft. in height, will contain 2,230,000,000 cubic feet: this single reservoir being 50 per cent. greater than the available water in Loch Katrine." Mr. Bateman estimates the cost for 220,000,000 gallons per day at £10,850,000, the interest upon which, together with cost of maintenance, &c., would be met by a domestic rate of 10d. in the pound, and a public rate of 2d. in the pound. The present rate paid to the London water companies is much heavier, being about 1s. 5d. in the pound. The total gathering ground in Mr. Bateman's scheme is estimated at 204 square miles.

Messrs. Hemans and Hassard's Scheme.—This scheme lays under contribution the magnificent condensing surface of the Cumberland and Westmoreland mountains, where, as every tourist knows, rainless days are rare exceptions. The extent of gathering ground would be 177 square miles, whilst the average annual rainfall in the district is 100·56 inches. The districts from which water is proposed to be taken lie on the northern slopes of the range of hills towering over Grassmere, Windermere, and Kendal, and draining into the rivers Lowther and Greta, and into the lakes of Haweswater, Ullswater, and Thirlmere. This scheme has the advantage of naturally-formed reservoirs, which would, however, require to be further enlarged by embankments; and these natural advantages are also to some extent counterbalanced by a greater length of conduit (280 miles), and by the necessity for several tunnels, two of which would be respectively 7¼ and 8 miles long. The daily delivery of water in London would be 250,000,000 gallons, and the cost of the works, &c., £13,500,000. The interest upon this capital, cost of maintenance, &c., and compensation to present water companies, would be met by a domestic rate of 1s. 1d. per pound.

From a chemical point of view, it is at present quite impossible to give the preference to one or the other of these colossal schemes, both of which are truly worthy of the latter half of this century of engineering triumphs, and of the great city on behalf of which they are projected. Before we can appreciate, however, the advantages of such magnificent undertakings, it is necessary that we should first consider the chemical quality of our present supply, and compare it with that of the water which we should obtain from these new sources.

Quality of the Present Metropolitan Water Supply.—Absolutely pure water is never found in nature. In addition to mechanically suspended impurities which can be mostly removed by filtration, potable waters also contain various solid substances in a state of solution. These substances are left behind as a solid residue when such waters are evaporated to dryness; they have been commonly classified by chemists into the three following divisions:—

1. Matters which are expelled when the solid residue is heated to redness in contact with air.
2. Matters which are not expelled at a red heat, and which decompose soap.
3. Matters which are not expelled at a red heat, and which do not decompose soap.

The substances of the first division consist of:—

a. Organic matter.

b. The products of the decomposition of certain mineral salts chiefly nitrites and nitrates.

Formerly ammoniacal salts, a certain amount of moisture, and even hydrochloric acid were amongst the products expelled on ignition, but since the adoption of the suggestion of Hofmann and Blyth in the year 1856 to add a known weight of carbonate of soda to the water before

evaporation, these substances have been excluded from category No. 1 and it is important to bear this in mind when comparing the analyse of waters made prior to 1856 with those which have been made since that year. Notwithstanding the more definite character, however, thus given to the matters expelled on ignition, it is still difficult to interpret the meaning of this loss. It may all arise from organic matter,—nay, there may even be more organic matter in the solid residue of a water than is indicated by the total loss on ignition, as I have recently had occasion to observe; or it may be all due to the dissipation of mineral ingredients, the result, however, of the decomposition of previously existing organic matter. When it is large it throws suspicion upon the character of the water, it indicates either the presence of organic matter, animal or vegetable, or it denotes previous contamination with sewage or decaying animal matters. This analytical determination is thus surrounded with much uncertainty; and it has always been considered, as indeed it deserved to be, highly unsatisfactory. Hence the attempts which have been made to indicate, directly or indirectly, by means of permanganate of potash, the amount of real organic matter involved in this loss by ignition. Permanganate of potash when dissolved in water readily yields oxygen to many substances capable of combining with this element. Thus if it be added to water acidulated with sulphuric acid, and containing oxalic acid in solution, the latter is completely and rapidly converted into carbonic acid and water at the expense of oxygen derived from the permanganate; and it is found that one part by weight of oxalic acid in being thus oxidized abstracts almost exactly eight parts by weight of oxygen from the permanganate, the latter being converted into sulphate of manganese. In undergoing this chemical change the rich violet colour of the solution of permanganate of potash vanishes; and it is thus easy to ascertain, by the non-disappearance of the characteristic tint of the permanganate, when the oxidation of the oxalic acid is complete. Now a similar disappearance of colour occurs when the solution of permanganate of potash is added to an acidulated sample of potable water containing organic matter; and it has been assumed that, as in the case of the oxalic acid, the organic matter contained in the water is completely oxidized by the permanganate, which was thus thought to indicate the amount of oxygen required to oxidize completely the organic matter contained in the water. Dr. Letheby has even employed this reaction for the estimation of the *actual weight* of organic matter contained in a known volume of water, on the assumption that every grain of organic matter contained in a sample of water robs the permanganate solution of eight grains of oxygen. Such a method of ascertaining the actual amount of organic matter in a water, or even the amount of oxygen required to convert this organic matter into its final mineral products of oxidation, would be invaluable on account of the extreme facility with which it can be applied; and it was therefore not without a certain amount of regret that, after employing this process for many months, I noticed unmistakeable symptoms of its untrustworthiness, symptoms which were amply confirmed on submitting it to rigorous experimental tests. By the addition of known weights of different organic substances to equal volumes of pure distilled water. the latter was artificially contaminated with a known proportion of each kind of organic matter. Each sample of water so artificially contaminated was made to contain three parts of organic matter in 100,000. I then proceeded to ascertain—first, the amount of oxygen which this organic matter abstracted from the permanganate of potash; and secondly, the actual amount of organic matter present in the water, on the assumption that each part by weight of organic matter consumed eight parts by weight of oxygen from the permanganate of potash. The same test was also applied to another sample of distilled water from which all organic matter was carefully excluded, but to each 100,000 parts of which three parts of nitrite of soda were added. The importance of this last experiment will be evident when it is stated that nitrite of soda is rarely absent from the different waters supplied to London. The amount of oxygen consumed by the organic matter was determined for two different periods of time, viz.:—first, for a period at the end of which the acidulated and contaminated water remained tinted with permanganate for ten minutes after the addition of the latter; and secondly, for a period of six hours, during the whole of which time the permanganate was present in excess.

The results are contained in the following table, where they are compared with the known amount of organic matter present and the known amount of oxygen which that organic matter would require for its complete oxidation.

1	2	3	4	5	6	7
Name of Substance, 3 parts of which were contained in 100,000 parts of water.	Oxygen absorbed in 10 minutes. (Experiments.)	Oxygen absorbed in 6 hours. (Experiments.)	Oxygen required to oxidise organic matter. (Calculated.)	Amount of organic matter present. (Calculated from Column No. 2.)	Amount of organic matter present. (Calculated from Column No. 3.)	Amount of organic matter actually present.
Gum Arabic............	·0102	·0350	3·55	·082	·280	3·0
Cane Sugar	·0064	·0152	3·37	·051	·111	3·0
Starch	·0143	·0302	3·55	·114	·241	3·0
Gelatine	·0792	·1836	6·76	·634	1·469	3·0
Creatin	·0080	·0172	6·59	·064	·138	3·0
Alcohol	·0093	·0164	6·26	·074	·131	3·0
Urea	·0092	·0119	6·40	·074	·095	3·0
Hippuric Acid	·0328	·0600	5·90	·262	·480	3·0
Oxalic Acid (crystallised)............	·3747	·3750	0·38	2·998	3·000	3·0
Nitrate of Soda	·6910	·6913	0·00	5·528	5·530	0·0

From this table it is seen that of the nine kinds of organic matter operated upon, only one was completely oxidized by permanganate of potash, even after the lapse of six hours, whilst it will be remarked that urea, hippuric acid, and creatin—three organic substances likely to be present in water recently contaminated with sewage—suffer an oxidation which, even in the most favourable case, only reaches one-fiftieth of complete oxidation; whilst if we attempt to calculate the amount of these substances present in the water, from the quantity of oxygen so absorbed, instead of finding three parts of each in 100,000 of water, we obtain only ·138 part of creatin, ·095 part of urea, and ·480 part of hippuric acid. On the other hand, the mineral salt, nitrite of soda, weight for weight, surpasses every form of organic matter experimented upon in the avidity with which it absorbs oxygen; and three parts of this inorganic substance in 100,000 of water would actually, by the mode of calculation above described, indicate no less than 5½ parts of organic matter. Thus it is evident that for the estimation of the amount of organic matter in water or the quantity of oxygen necessary to oxidise that organic matter, permanganate of potash is utterly untrustworthy and fallacious. Whilst, however, this re-agent is quite worthless for the quantitative estimation of organic matter in water, it may still be used in certain cases as a qualitative test where there is no opportunity for accurate analytical examination. Thus, if a clear and colourless water decolorises much of the permanganate solution, the water ought to be rejected for domestic use as being of *doubtful* quality; for although such a water may be absolutely free from organic impurity, yet its decolorising action upon the permanganate would indicate with considerable certainty that the water had been in contact with decaying animal matters. Should the water, however, instead of being colourless, be tinged of a yellow or brownish-yellow colour when viewed through a considerable stratum, as in a quart decanter for instance, its capability of decolorosing a considerable amount of permanganate solution ought not to be regarded with the same suspicion as in the case of a colourless water, because the yellow tint of such waters is generally owing to the presence of peaty matter, which, though innocuous, has the power of decolorising permanganate of potash.

Having thus convinced myself of the fallacy of the permanganate process of analysis, and there being no other method by which the estimation of organic matter in waters can be even approximately effected, I have, for some months past, in conjunction with my pupil, Mr. Armstrong, been endeavouring to remedy this grave defect in water analysis; and we have at length succeeded in replacing the unsatisfactory item of "organic and other volatile matter," by certain precise and definite determinations, which throw great light upon the present condition and previous history of the sample of water submitted to analysis.

The two most important things to be ascertained about a water used for domestic purposes are, first—the amount and character of the organic matter present in the water at the time of analysis; and secondly, the amount of hardening or soap-destroying materials which the water contains. Unfortunately, the first of these data cannot be ascertained; but we have devised processes by which the amount of the two most important elements of organic matter, carbon and nitrogen, can be determined with considerable precision. For this purpose the following processes are necessary:—

1. Determination of the carbon contained in the organic matter. To distinguish this carbon from that which is contained in the mineral carbonates present in most waters, I will term it *organic carbon.*

2. Determination of the total combined nitrogen. This nitrogen may exist in the water in one or more of the three following forms:—*a.* As a constituent of organic matter—*organic nitrogen.* *b.* As a constituent of mineral nitrites and nitrates. *c.* As a constituent of ammonia.

3. Determination of the nitrogen present as nitrites or nitrates.

4. Determination of ammonia.

5. Calculation of amount of organic nitrogen. This is obviously a

very simple operation, for if from the amount of total combined nitrogen (determination No. 2), there be deducted the amount of nitrogen present as nitrites and nitrates (determination No. 3), plus the amount of nitrogen present in the ammonia (determination No. 4), the remainder will be the amount of organic nitrogen.

The process by which these determinations are made will be fully described elsewhere.

(To be continued.)

THE ECONOMICAL PRODUCTION OF MINERAL OILS.

The manufacture of mineral oils, more especially by the distillation of the shaly deposits abounding in the north, has for some years been an important branch of British industry. The introduction, however, from America, of the cheaper but more explosive petroleum or rock oil,* has had a most depressing effect upon our home manufacture of mineral oils, the properties of many of our mineral oil works having been so much depreciated in their value as to render these unremunerative, and unable to compete in the market with the low-priced American oils. Many valuable mineral resources have thus been brought to a state of comparative inactivity.

Any efforts made with a view to resuscitate these dormant works, must be hailed with satisfaction. Now, it should be borne in mind that the most important feature to be kept in view, in the carrying out of this very desirable object is, that the cost of manufacturing these oils shall be reduced to the lowest possible figure that will allow of their being of good marketable quality.

The chief items in the cost of production may be taken as being represented by the outlay for fuel, and the working expenses.

As the result of careful study and attention to these points, some experiments made by Mr. Chas. McBeath, of Blackburn, near Bathgate, have recently been brought under our notice. Mr. McBeath's object in making these experiments was to ascertain the capabilities of an arrangement of distilling apparatus, recently patented by him, for the treatment or distillation of shale coal and other bituminous substances, which allows of the poorest as well as the richest shales being profitably worked. Mr. McBeath finds that, on treating a poor description of shale with his experimental apparatus, he had a yield of 21 gallons of crude oil per ton of shale, and that this crude oil, tested at a specific gravity of 8·60, gave 50 per cent. of burning oil—free from the explosive risks of the American petroleum—20 per cent. of paraffine, and 30 per cent. of lubricating oil and tar. By the ordinary process a yield of no more than 18 gallons of crude oil would be obtained from a ton of shale, and these would yield only 40 to 45 per cent. of burning oil, and about 16 per cent. of paraffine.

If, therefore, the results of the trials made by Mf. McBeath are also as satisfactorily realised by the apparatus being tested on a large scale, we may hope that the poorer as well as the richer kinds of shale, of which there are in this country such extensive deposits, will soon be utilised, and profitably worked, so as to afford a stimulus to this branch of industry, and cause our home manufacture of mineral oils once more to recover from its present lethargy.

The following are the distinguishing features of Mr. McBeath's apparatus and process:—Instead of the usual close retort, whether heated internally by superheated steam, or on the outside surface by the use of *special* or separate fuel, Mr. McBeath employs an open-ended retort, placed vertically, with the lower mouth open all round at the base, over a hearth; the retort is charged in at the top with the shale, and, when full, the shale is ignited at the annular open mouth all round the hearth, by wood or coal in the first instance; but, when properly kindled it will keep constantly burning, with ordinary attention, and clearing away of the ashy deposits. The distillation of the shale is thus effected by the heat of its own combustion, the rate of which is regulated by the admission of air at the doors of the hearth and ash-pit formed at the base of the retort, so as to keep the shale burning at the proper degree of heat. The hot gases generated at the base of the retort will then ascend through the column of unburned shale, and prepare it for ignition as it reaches the open mouth and hearth. The gases, on reaching the top of the retort, are conducted away to the condenser.

Another important feature in Mr. McBeath's invention, and which assisted materially in bringing about the successful results at which he has arrived, consists in the introduction of a jet of steam at the neck of the conduit conveying the distilled gases from each of the retorts of a bench or series to the condensers. This feature may also be applied with advantage to ordinary retorts and condensers as used for the distillation of mineral oils. The introduction of the steam jet has the effect of drawing off the gases from the retort, so as to assist the combustion of the shale, and the draught of air passing into the mouth of the retort; it also superheats the gases, and forces them down the conduit to the condenser, where the liquefaction of the gases is thus materially assisted, and with advantage to the quality and value of the resultants obtained. The jet of steam may be used either solely for the purpose of superheating, drawing, and forcing the gases direct from the retort to the condenser, or may be utilised also for re-heating, drawing, forcing, and returning through the condensing part of the apparatus a portion of the gases which have previously escaped uncondensed. The latter operation may, in some cases, be assisted by the action of a fan blower.

A special arrangement of McBeath's condensing apparatus consists mainly of a large cylindrical vessel connected to the throat-pipe forming the outlet from the retort, from which it declines at an angle, and rests on supporting blocks or pillars. This condensing vessel is fitted with a series of diagonal surface-condensing pipes, in pairs, open to the atmosphere, and through which the cold air circulates; a supplementary small condensing vessel is placed over each main condenser, connected to it at its lower end, and the upper end of the supplementary condenser is connected by a branch and nozzle pipe to the throat pipe leading from the retort to the main condenser, so as to allow of the uncondensed heavy or olefiant gases, being returned again through the condenser, and the others of the series with which it is connected. The nozzle for the steam jet is passed through to the interior of the upper extremity of the main condenser; and, by the force of the steam injected through the nozzle, a portion of the gases, which have not been condensed upon their second passage through the condenser, is again drawn and forced into the upper end of the main condenser along with the fresh gas passing over from the retort. Thus both currents of gas are drawn and superheated, and forced into the main condenser, where they are liquefied on coming into contact with the interior of the condensing tubes within it.

In this arrangement of condensing apparatus each retort of a bench or series has its own condenser acting separately and independently; and provision is made to regulate or shut off at pleasure the return current of uncondensed gases from the upper part of any one of the series of condensers; and, when so shut off, the steam would act upon the fresh gas only, so as to draw, superheat, and force it into the condenser, and thus each distilling apparatus could either work with or without the return current of non-condensed gases.

We may add that the only attendance required by Mr. McBeath's distilling apparatus is for the purpose of keeping the retort charged, and removing the ashy deposits from the hearth: to facilitate this latter, the hearth is formed of a conical shape, so as to assist in the withdrawal of the ashes. The successful working of this apparatus will, doubtless, go far to assist the mineral oil industry, chiefly of North Britain, in recovering from the torpor into which it has fallen since the discovery of the abundant oil strata of Pennsylvania.

* The Director of the Chemical Laboritaries of the Pharmaceutical Society has recently written a letter upon the subject of the dangers of these petroleum oils, in which he remarks that 90 per cent. of the common petroleum sold in retail shops as lamp oil, gives off an inflammable vapour at a temperature many degrees below 100, some at the ordinary temperatures of 70° and 80° Faht.; that of sixty specimens examined, only two were free from danger; and as the oil burnt in a common lamp always becomes heated to 108° or 110° just before it leaves the interior of the lamp, it follows that, if the oil gives off inflammable vapour below that temperature, an explosive mixture of vapour and air is produced in the lamp, needing only the accidental application of a light to explode the vessel. For, though the petroleum ordinarily sold for illuminating purposes is vended as lamp *oil*, it is in reality a mixture of *spirit* and oil; it is the business of the refiner to separate the spirit from the oil, but, hitherto, this separation has only partly been effected, and so long as a liquid containing a spirit is sold to the public as an oil, so long there will be frights and fires attending the use of petroleum.

ON NAPHTHA AND ILLUMINATING OIL FROM HEAVY CALIFORNIA TAR (MALTHA).

By Professor B. Silliman.

(From the American Journal of Science and Arts.)

Having lately had an opportunity to examine a specimen of "surface oil," so called from Santa Barbara county, in California, I present the following experimental results in the hope that they may not be without interest, as an addition to our knowledge of one extreme of that class of hydrocarbons which occur in nature in the fluid form, and of every density, from those which are but little lighter than water down to the lightest naphtha found in a natural state.

It is proper to state that the chemical examination of this sample had chiefly a technical object, to prove whether or not illuminating oil of good quality could be obtained from the distillation of so dense a body. The experiments were conducted on quantities of from five to ten gallons each. The crude oil was very dark, almost black, transmitting yellow brown light in thin films. At

ordinary temperatures (60°) it is a thick, viscid liquid, resembling coal tar, but with only a very slight odour.

Its density at 60° F. is 0·980 or 13° Baumé. It retains, mechanically entangled, a considerable quantity of water, which is neutral in its reaction. The odour of sulphydric acid, which is very decided in this product, as I have noted in its locality, had entirely disappeared in the specimen under consideration.

The tar froths at the commencement of distillation, from escape of watery vapour. It yields by a primary distillation no product having a less density than 0·844, or 37° B. at 52° F.

Distillation to dryness produced in two trials an average result as follows:—

Oil having a density of ·890 to ·900	69·82
Coke, water, and loss	30·18
	100·00

In one of these trials the product was divided as follows:

Oil, of density 29° B. at 52° (·885 sp. gr.)	50·0
" 24·75 " 53° (·908 ")	17·5
Cake, water, loss, &c.	32·5
	100·0

The coke is very large in quantity, strong, and is a good fuel, resembling gas-house coke. The odour of ammonia is given off towards the close of the distillation.

It is well known to distillers of petroleum that by the process called "cracking," heavy oils unfit for illumination are broken up into bodies of less density, from light naphtha to the heavier illuminating and lubricating oils. This process is simply the application of a carefully regulated heat producing a slow distillation. By this treatment the molecules apparently re-arrange themselves into groups of different density, which by a subsequent distillation are divided into fractions (or "heaps" as Mr. Warren calls them) of tolerably constant boiling points.

The first distillate, having a density of about ·890 at 60° F., treated in this manner, yielded a product having a density of about ·885 at 60°, or only 1° Baumé lower than before distillation. After treatment with sulphuric acid and soda and redistilling from soda, it had a density of ·880 at 60° F. Upon redistilling, 100 measures of this last distillate yielded—

Light oil having a density of about ·834 at 60° F.,	21·58
Heavy " " ·880 " 66° F.,	37·41
" " " ·916 " 64° F.,	34·53
Coke, &c.	6·48
	100·00

In another experiment undertaken with a view to "cracking," &c., treating and redistilling with soda, the products were as follows, stated in percentages of the whole quantity operated on, the several steps being as before.

Naphtha,* sp. gr. about ·760 at 60° F.,	11·33
Oil,† " " ·836 "	66·22
" " " ·893 "	12·67
" " " ·921 "	3.56
Loss	6·22
	100·00

The illuminating oil from both these experiments, after treatment with sulphuric acid and soda in the usual manner, acquired an agreeable odour, a light straw-yellow colour, and burned as well in a lamp as good commercial oil.

With a view to test the effect of heat aided by pressure in breaking up the heavy hydrocarbons—a method of treating heavy hydrocarbon oils patented in 1866 by Mr. James Young of Glasgow—a portion of the first distillate from the crude oil was subjected during distillation to a pressure of 10 to 15lbs. to the square inch, in an apparatus adapted to the purpose, the distillate thus obtained being about the same density as in the first-named experiment, ·890 at 60° F.

From this distillate were obtained, after the ordinary treatment with sulphuric acid and soda, the following products:—

Light oil, sp. gr. ·825 at 60° F.,	19·2 p. c.
Heavy " ·885 "	25·86 "
" " ·918 "	38·14 "
Coke, loss, &c.,	16·80 "
	100·00

The illuminating oil from the last experiment flashed at 80° F. and lighted on the surface at 85° F., showing the presence of naphtha or some very light body, the quantity of which cannot be very considerable. The light oil could with care be taken off in practice without materially diminishing the yield of illuminating oil. It would be rash to conclude that there may not be an important economical advantage in employing, in the large way, Mr. Young's method of treatment under pressure, over that of "cracking" by a regulated heat alone. It is highly probable that there would be found an important saving of time, as under a regulated pressure and a corresponding increase of temperature, the transformation of the heavy oils into a mixture of those of less density, will occur more speedily. The experiments herein mentioned gave nearly the same result whether pressure was used or not; a certain loss, all falling upon the lighter portions, was found to result from leakage of the apparatus under pressure, which in the larger way of operating commercially could be avoided.

* This naphtha caught fire from a match at an atmospheric temperature of 56° F.
† This oil flashed at 113° F. and ignited at 124° F.

No paraffine could be detected by refrigerating the heavy oils obtained in these distillations in a mixture of salt and ice. It is no doubt the absence of this body from the series of products obtained from the California oils generally, that accounts for the illuminating oil burning well at a density considerably below the commercial standard for oil obtained from Pennsylvania petroleum—a difference enhanced also by the absence of any considerable quantity of light naphtha. The lubricating oils of this series, likewise free from paraffine, retain on this account their fluidity at low temperatures.

The light oils obtained in this series of experiments correspond respectively to 12·96, 14·56 and 18·96 per centum of the crude oil. The total commercial products are about 60 per cent. of the crude body, which likewise yields sufficient coke to supply the fuel required in the distillations.

In the large way, by returning the lightest oils to the heavier portions in the successive distillations and employing Mr. Young's method by pressure, it is probable the product of light or illuminating oils may be raised in these very heavy natural products to 30 per cent.

It is evident from these experiments that heavy hydrocarbon oils containing no naphtha are convertible into oils of the naphtha series under the action of heat by molecular transformations, the excess of carbon being left behind as coke; each successive distillation eliminating a new, but always a diminished, portion of carbon.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents

ST. MICHAEL'S MOUNT.

To the Editor of The Artizan.

I have before me an authorised report of a lecture, delivered by William Pengelly, Esq., F.R.S., on "The Insulation of St. Michael's Mount, Cornwall," at the Royal Institution, on April 5th, 1867. He arrives at the conclusion that the Mount cannot have become an island by the retrogression of the sheltered cliffs, even within so long a period as the last 16,800 years; and he has also stated that its insulation was necessarily the result either of subsidence or of a subsequent retreat of the coast line in consequence of the wasting action of the waves, (p. 3.) We are, therefore, agreed that the insulation was caused by subsidence or sinking. The latest subsidence need not by any means be referred back to the pre-historic mammoth era, p. 4, from the circumstance of mammoth bones having been found—for the obvious reason that those bones may have risen and sunk again and again with the ground on which they were deposited. It has already been pointed out in these papers that the chroniclers have often omitted to record the disappearance of land, from whatever cause, and they may, therefore, have done the like in the present instance. There does not appear to have been any mention of the Mount *as an island*, either in Edward the Confessor's charter, date 1044, or in the Pope's grant of a remission of penance in 1079; in short the attempt to establish its insulation previous to 1099 is an entire failure. That remission, however, which appears to have been granted "to all persons who should visit the church of St. Michael at the Mount, with oblations and alms"—corroborates the statement at the end of Article 157, that the mount really was the identical territory which was given to Mont St. Michael on the Norman coast, notwithstanding the mention of four St. Michaels, at p. 11. On the same page it is mentioned that the mount only measures seven acres. If that be so, so much the better for my argument, and so much the worse for that of my friendly opponent, for there are now it appears no less than 233 acres missing since 1086. It is at any rate very fair of my friend to have given this measure of seven acres. I have, however, before me the Ordnance Map, scale one inch to a mile, from which, with the assistance of a microscope, it appears that the average length and breadth of the Mount are about 22 by 14 chains=30·8 acres. It appears that Carew, in 1602, says, p. 8:—"Tradition tells us that in former ages the mount was part of the insular continent in Britain, and disjoined from it by an inundation or encroachment of the sea, some earthquake or terrestrial concussion." I offer my friend most sincere thanks for the candour with which his statements are made, and am now quite satisfied to leave the date of the insulation of the mount to the reader's judgment.

Yours truly,

R. A. Peacock.

REVIEWS AND NOTICES OF NEW BOOKS.

The Strains on Structures of Ironwork, with Practical Remarks on Iron Construction. By F. W. Shields, M. Inst., C.E. Second edition. London: John Weale, 1867).

The first edition of this work was noticed in our issue of May 1st, 1861, and we are glad to find that the favourable opinion we then expressed on its merits, has been borne out by the success it has found with the

engineering public, and owing to which a new edition has become necessary after the lapse of six years. Both the letter-press and the illustrations of this edition are identical with those of the first, and, therefore, we need hardly add anything further to our previous remarks on this valuable epitome of the practice of iron construction.

A Treatise on the Art of Constructing Oblique Arches with Spiral Courses. By William Donaldson, M.A. Cantab., Assoc. Inst. C.E. (London: E. and F. N. Spon. 1867.)

The author of this treatise endeavours to overcome the difficulties with which the construction of oblique arches is beset, by substituting a mathematical operation by means of a series of formulæ for the usual graphic or plastic mode of developing the oblique surfaces on a large scale. No doubt, the formulæ given by Mr. Donaldson are very useful in their way, though, from their great complication, they will alarm those not thoroughly acquainted with differential and integral calculus; but as, by the use of the results arrived at, the main data required in practice may be worked out algebraically, and without the aid of the symbols $\int$ and d, a knowledge of the rudiments of algebra will suffice for the practical application of these results. On the other hand, we decidedly demur to the author's assumption, that the manipulation of mathematical formulæ can ever supersede skill in draughtsmanship in any branch of architecture or engineering. A thorough acquaintance with the theoretical part of these professions is not only a *desideratum,* but is becoming more and more indispensable; yet, it must necessarily go hand in hand with practice, and it is only a combination of both that will warrant self-reliance, and ensure eventual success. Science can never become a substitute for skill or taste; integrals and differentials do not give elegance and beauty to design, though they may serve as efficient checks, and though, in fact, mathematical accuracy be the first and foremost requisite, Mr. Donaldson's little work will doubtless prove very useful to all those familiar with analytical operations, but the final results must necessarily be taken *cum grano salis,* so as to allow ample scope for the display of intuitive skill.

Etudes sur l'Exposition de 1867, *ou les Archives de l'Industrie au XIX^e^ Siècle. Par MM. les Rédacteurs des Annales du Génie civil.* Eugene Lacroix, Directeur de la Publication. (Paris: E. Lacroix. 1867.) Parts I. and II.

It gives us much pleasure to draw the attention of our readers to this excellent serial publication, issued under the auspices and with the concurrence of the usual contributors of our flourishing French contemporary, the "Annales du Génie Civil." It is designed to treat of all the branches of industry represented in this year's world's fair, or, to quote the language used on its title page, "to give a general, encyclopædic, methodical, and rational view of the present state of art, science, industry, and agriculture in all countries." The character of the articles published in the first two parts that have been issued, warrants the inference that the *tout ensemble* will form a work highly creditable to its individual authors, as well as to our enterprising *confrère,* M. Lacroix. The subjects treated of in these parts are:—The fine arts, by Mr. Daguzan; printing and dyeing of woven fabrics, by Dr. Kæppelin; agricultural engineering, by Mr. Grandvoinnet; watchmaking, by Mr. Berlioz; steam engines, by Messrs. Gaudry and Ortolan; tar industry, by Mr. Knab; furniture, by Mr. L. Château; and several others. Some very good lithographic engravings are appended, and altogether this publication is got up in excellent style. If the subsequent numbers are equal to those already issued, we have no doubt that well-deserved success will attend the efforts of its conductor.

Scientific Journal. A Weekly Record of Scientific and Practical Information of Manufactures, Inventions, Mechanics, the Arts, &c. Vol. I. Philadelphia: Espineul and Reed.

This periodical, which made its first appearance on May 8th last, is got up in a style somewhat similar to that of our other Transatlantic contemporaries. In the numbers issued up to the present it devotes itself chiefly to recording the progress of mechanical industry in Europe, by selections from English journals, and less to those subjects that form the staple of the rival publications of New York. A special feature of the "Scientific Journal" is the introduction of some well-written biographical sketches of "leading inventors and useful men," three of which, viz., the lives of Barton H. Jenks, Matthias W. Baldwin, and William Norris, have already been given. We are happy to extend the hand of good-fellowship to this the youngest of our contemporaries in the periodical literature of science and industry.

LATEST PRICES IN THE LONDON METAL MARKET.

	From £	From s.	From d.	To £	To s.	To d.
COPPER.						
Best selected, per ton	82	0	0	83	0	0
Tough cake and tile do.	79	0	0	81	0	0
Sheathing and sheets do.	81	0	0	83	0	0
Bolts do.	83	0	0	,,	,,	,,
Bottoms do.	88	0	0	,,	,,	,,
Old (exchange) do.	72	0	0	,,	,,	,,
Burra Burra do.	87	0	0	88	0	0
Wire, per lb.	0	0	$11\frac{1}{4}$	,,	,,	,,
Tubes do.	0	0	$11\frac{3}{4}$	,,	,,	,,
BRASS.						
Sheets, per lb.	0	0	9	0	0	10
Wire do.	0	0	$8\frac{1}{2}$	0	0	$9\frac{1}{2}$
Tubes do.	0	0	$10\frac{3}{4}$	,,	,,	,,
Yellow metal sheath do.	0	0	$7\frac{1}{4}$	,,	,,	,,
Sheets do.	0	0	7	,,	,,	,,
SPELTER.						
Foreign on the spot, per ton	21	0	0	,,	,,	,,
Do. to arrive	21	0	0	,,	,,	,,
ZINC.						
In sheets, per ton	27	0	0	,,	,,	,,
TIN.						
English blocks, per ton	89	0	0	,,	,,	,,
Do. bars (in barrels) do.	90	0	0	,,	,,	,,
Do. refined do.	92	0	0	,,	,,	,,
Banca do.	92	0	0	,,	,,	,,
Straits do.	86	0	0	86	10	0
TIN PLATES.*						
IC. charcoal, 1st quality, per box	1	8	0	1	10	0
IX. do. 1st quality do.	1	14	0	1	16	0
IC. do. 2nd quality do.	1	4	0	,,	,,	,,
IX. do. 2nd quality do.	1	10	0	,,	,,	,,
IC. Coke do.	1	3	6	1	4	0
IX. do. do	1	9	6	1	10	0
Canada plates, per ton	13	10	0	,,	,,	,,
Do. at works do.	12	10	0	,,	,,	,,
IRON.						
Bars, Welsh, in London, per ton	6	10	0	6	15	0
Do. to arrive do.	6	10	0	,,	,,	,,
Nail rods do.	7	0	0	8	0	0
Stafford in London do.	7	10	0	8	10	0
Bars do. do.	7	10	0	9	10	0
Hoops do. do.	8	12	6	9	12	6
Sheets, single, do.	9	10	0	11	0	0
Pig No. 1 in Wales do.	4	5	0	4	10	0
Refined metal do.	4	0	0	5	0	0
Bars, common, do.	5	15	0	6	0	0
Do. mrch. Tyne or Tees do.	6	10	0	,,	,,	,,
Do. railway, in Wales, do.	5	15	0	6	0	0
Do. Swedish in London do.	10	5	0	10	10	0
To arrive do.	10	10	0	,,	,,	,,
Pig No. 1 in Clyde do.	2	15	0	3	5	0
Do. f.o.b. Tyne or Tees do.	2	9	6	,,	,,	,,
Do. No. 3 and 4 f.o.b. do.	2	6	6	2	7	0
Railway chairs do.	5	10	0	5	15	0
Do. spikes do.	11	0	0	12	0	0
Indian charcoal pig in London do.	7	0	0	7	10	0
STEEL.						
Swedish in kegs (rolled), per ton	14	0	0	14	10	0
Do. (hammered) do.	15	5	0	15	10	0
Do. in faggots do.	16	0	0	,,	,,	,,
English spring do.	17	0	0	23	0	0
Quicksilver, per bottle	6	17	0	,,	,,	,,
LEAD.						
English pig, common, per ton	19	17	6	,,	,,	,,
Ditto. L.B. do.	20	0	0	20	5	0
Do. W.B. do.	22	5	0	,,	,,	,,
Do., ordinary soft, do.†	20	0	0	20	10	0
Do. sheet, do.	20	15	0	,,	,,	,,
Do. red lead do.	20	15	0	,,	,,	,,
Do. white do.	27	0	0	30	0	0
Do. patent shot do.	23	0	0	,,	,,	,,
Spanish do.	19	10	0	,,	,,	,,

* At the work 1s. to 1s. 6d. per box less.
† A Derbyshire quotation, not generally known in the London market.

NOTICES TO CORRESPONDENTS.

E. N.—The adaptation of the engines in question to screw propellers, instead of paddle wheels, takes place by simply inverting the cylinders and placing them overhead, instead of downwards. The conversion of the rectilinear into circular motion is similar to the one usual in land engines, *i.e.*, the cross head keyed on to the piston of the low-pressure cylinder works in slides, and the connecting rod, being attached to the cross head by means of straps, gives motion to the crank which is forged on the engine shaft; the latter actuates the screw shaft by means of a wheel and pinion.

J. D. C.—The guage of the Spanish and Portuguese railways is 1m. 67cm., or 5ft. 5½in. This guage was legally established in the Iberian peninsula, upon the laying down of the first lines, to prevent the possibility of an invasion from France.

R. F.—The data given in the French work alluded to are altogether obsolete. The Belgian publication gives the figures much more correctly.

A. P.—An engine of the power quoted will be amply sufficient for all your requirements. The grinding will be done most efficiently by edge runners.

Erratum.—In the Artizan for June 1st., page 221, col. 1, line 3 from the bottom, read 22.6 instead of 26·6.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Liability of Railway Companies for Accidents Arising from Latent Defects—Redhead v. the North Midland Railway Company.—This was the first case in which the question had arisen distinctly in the superior courts in this country, whether railway companies are liable on the ground of warranty for the consequences of latent defects, not discoverable by any care or skill. Plaintiff had been injured by the breaking down of a carriage in which he was travelling as a passenger on the company's line, the accident arising from the fracture of one of the wheel tyres which broke through a latent flaw in the welding. The tyre, though of sufficient strength and thickness in appearance was, in point of fact, weakened by an air bubble, constituting a defect entirely unknown to the maker himself, and which could not be detected by the company's servants by whom it was examined in the usual manner before the journey. The case had been tried at the Durham Assizes, when Justice Lush directed the jury to find for the defendants, on the ground that the company were not responsible, as they were liable only for negligence, which was disproved. A motion was then made on the part of the plaintiff, in the Court of Queen's Bench, on May 15th, to set aside the verdict for misdirection, on the ground, that the company were liable on an implied warranty that the carriage was safe and secure. The case chiefly relied upon by the plaintiff was that of Sharp v. Grey, decided in the old coaching days, in 1833, and in which a coach proprietor was held liable for an accident caused by a defect in the iron axle-tree; in that case, however, the flaw was discovered on close examination of the iron itself, though not without taking the axletree entirely to pieces. In the present instance, Justice Blackburn held that the question at issue was, whether the obligation of the carrier was merely to take every precaution and to procure a carriage reasonably sufficient—in which view the direction in this case was right—or whether it was an absolute obligation at his own peril to supply a carriage which should be safe—in which case the direction was wrong; the learned judge took the latter view of the case. The other three judges, however, viz., Justices Lush, Mellor, and Shee, forming the majority, were of opinion that the carrier of passengers could be held liable only for negligence, not for defects discoverable only by "the miscroscopic eye of science." The judgment for the company was consequently affirmed.

Liability of Railway Companies for Damage Arising in Consequence of Execution of their Works.—Rukib v. the Metropolitan Railway Company.—The plaintiff in this case was a tradesman whose business had suffered considerably by the works undertaken by the defendants. The company, in forming a tunnel under a public carriage way, and in the lawful exercise of their parliamentary powers, caused a temporary obstruction of parts of the carriage road, and placed a hoarding on each side of it. The obstruction was continued for about twenty months, and at the end of that time all the streets and highways in the neighbourhood of the plaintiff's house were restored to their former state. Upon an action being brought by the plaintiff against the company, in the Sheriff's Court of Middlesex, the jury found that no injury had been done to the plaintiff's premises, but that he had sustained damage to the extent of £100 to his trade. Upon a special case being formed, t bis jndgment was affirmed by the Court of Queen's Bench, but reversed by the majority of the judges of the Court of Exchequer Chamber. It was then taken to the House of Lords, and on May 10th it came on for final consideration. The Lord Chancellor held that the damage which was the foundation of the plaintiff's claim to compensate was too remo e to have been the subject of an action at Common law, if the company's acts had been done without the authority of Parliament, and that *a fortiori* the claim was untenable where the defendants had the additional benefit of parliamentary powers on their side. Lord Cranworth concurred, whilst Lord Westbury dissented. The judgment of the court below having thus been affirmed by the majority of the judges of the House of Lords, their decision acquires legal force for the future. The sum and substance of this decision is, that railway companies are not liable to pay damages for such injury as tradesmen's business may suffer in consequence of works undertaken by such companies in conformity with their parliamentary powers.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Reclamation of Land from the Sea.—Another 700 acres of land have just been added to that reclaimed by the Norfolk Estuary Company in the Wash, by the completion of an embankment of two miles in length, at North Wooton. This makes a total of about 4,000 acres of the 32,000 to be recovered from the sea, for which the necessary funds were raised by the authority of an Act of Parliament, in 1849. The great difficulty was in the commencement of the work, owing to a bank off Wolferton being faced with Snettisham car stone, which, though soft when cut from the pit, hardens when exposed to the atmosphere. The cost of enclosure is about £10 per acre, while the value of the land enclosed is estimated at £50 per acre. The bank of the last enclosure has been made continuously, without leaving openings for the tides to pass through, as had hitherto been the practice.

The Export of Coal from the United Kingdom continues to increase. It amounted in 1866 to 9,953,712 tons of coals, cinders and culm, of the value of £5,102,805, being an increase of 783,235 tons over the export of 1865. Ten years ago the export did not reach 6,000,000 tons. Of the total quantity for 1866 1,931,236 tons went to France. The quantity of coals, cinders and culm shipped coastwise in the United Kingdom in 1866 was 10,720,824 tons, as against 10,928,237 tons in 1865. Upwards of 6,000,000 tons were brought into the port of London in 1866, viz., 3,033,193 tons coastwise, and 2,969,869 by inland navigation and railway.

The Supply of Coal to the Metropolis amounts to 5,600,000 tons per annum, being 7 per cent of the entire yield of the United Kingdom. About 50 per cent of this quantity is carried by sea. Of the total supply, about 46 per cent is credited to Newcastle, and about 33 per cent to Derbyshire.

The Palliser Chilled Iron Shot.—It appears that the Ebbw Vale Company are at present producing this newly-invented shot in preference to other makers. This company purchased, a short time ago, the only mine of spathose iron known in Monmouthshire, which, when mixed in the furnace with their other ores, produces the quality of iron which is so much desired. This deposit of spathose ore was discovered by the late Mr. Ebenezer Rogers of Abercarne.

NAVAL ENGINEERING.

The Austrian Navy.—Austria has at present, besides the eight iron-clad frigates. which took part in the combat of Lissa, one similar ship of the line, the *Kaiser*, in commission, and another, the *Oesterreich*, nearly completed. The latter is destined to act as a ram. Her plating is 8in. thick, and she will carry a 120 cannon with a monster spur. Besides, four other armour-plated frigates, viz., the *Tegethoff*, and three more offered by Hungary as a coronation present to her King, will shortly be finished. Austria, therefore, in the month of July at the latest, will possess 14 iron-clads, that is to say, as many as Russia. The hull of the frigate *Lissa*, building at Trieste, in Jonello's yard, will, according to the contract, cost 1,150,000fl. (£115,000), payable in six instalments. She will be equipped and have her armour completed by November. Her engines are to be of 1,000 horse-power, and 5,300 tons of iron will be used in her construction; she will carry 11 300-pounder Armstrongs, each of which will cost £1,213.

The "Wilhelm I." iron clad frigate, now building for the Prussian Government in the yard of the Thames Iron Works, was originally ordered for the Turkish Navy. She is designed by Mr. E. J. Reed, and will have 355ft. 10in. in length, 60ft. breadth, and a draught of water of 24½ft. forward and 26½ft aft. The thickness of her armour will be 8in., her tonnage 5,938; the power of the engines 1,150 horse nominal and the displacement 9,761 tons. The armour will extend about 7ft. below the water line. The *Wilhelm I.* will carry 30 guns, 15 being placed on each broadside, two commanding ahead and one astern. Many of these will be 50 ton guns, carrying 500 lb. shot, and the armament of this vessel will, with her broadside, stem and stern batteries, command every part of the horizon.

The "Orellana," steam troopship, 626 tons, 260 h.p., has lately been added to the Imperial Navy of Brazil. This vessel contains accommodation for 500 men, besides cabin accommodation for officers, &c. She is intended to carry troops along the coasts of Brazil and over the track of the great rivers.

H.M. Steam Transport "Euphrates," built by Messrs. Laird Bros., Birkenhead, having received her rigging and completed her fittings about the end of May last, was formally handed over to Government. She is the first of the five transports intended for the Indian relief troop service *via* Suez. Her length is 365ft., beam 49ft., maximum draught of water 21ft., tonnage 4,173 tons. Her engines, which have also been constructed by Messrs. Laird, are of 700 h.p. nominal; the cylinders are 94in. in diameter, with 4ft. 6in. stroke. The accommodation of the *Euphrates* is for 1,450 persons, viz., 1,250 military, and 200 crew.

The "Myrmidon," unarmoured screw war steamer, was launched from No. 6 building slip at Chatham Dockyard, on June 5th. She is of the "Wanderer" class of vessels and was laid down as far back as July, 1860, from the design of Mr. Isaac Watts, the late Chief Constructor of the Navy. She has now been strengthened by the removal of the wooden deck beams under the guns, for which patent iron beams, from the Butterly Works, have been substituted. The topsides have been strengthened by iron stringer plates and stiffening bars. The following are the principal dimensions:—Length between perpendiculars, 185ft.; length of keel for tonnage, 165ft. 7½in.; extreme breadth, 28ft. 4in.; breadth for tonnage, 28ft. 1in.; breadth moulded, 27ft. 6in.; depth of hold, 14ft.; burden in tons, 694 66-94. Her draught of water on launching was 7ft. forward and 9ft. 5in. aft., and her displacement 500 tons. The armament of the *Myrmidon* will consist of one 7-in. 6½ ton gun, and one 64-pounder, on pivots; and two 20-pounder breech-loading chase guns. This vessel was launched with the whole of her engines and machinery fitted on board.

SHIPBUILDING.

THE "DANAE" sloop of war, constructed from designs prepared by Mr. E. J. Reed, was successfully launched from Portsmouth Dockyard, on May 21st. Her dimensions are as follows:—Length between perpendiculars, 212ft.; length of keel for tonnage, 185ft. 8in.; extreme breadth, 36ft.; breadth moulded, 35ft. 2in.; breadth for tonnage, 35ft. 10in.; depth of hold, 19ft. 4in.; tons burthen (B.M.), 1,286 8-94. The *Danae* is a wooden ship, furnished with 6 iron bulkheads; she is of the *Amazon* class—the plough bow being modified—and is expected to attain a speed of 13 knots. Her engines are of 350 horse-power. She will carry on her broadside two 6½ ton 7-in. muzzled-loading rifled guns, and also two 64-pounder muzzle-loading rifled guns pointed through ports over her stem and stern port heads.

THE SCREW STEAMER "FRANCE," built for the National Steamship Company, was launched at Liverpool, on June 4th, from Messrs. Royden and Sons' yard, on the Mersey. This is stated to be the largest merchant ship ever built on this river, her length being 370ft., and her tonnage 3,610.

THE RECENT GUNBOAT CONTRACTS.—In the "Notes of Shipbuilding and Marine Engineering in the Clyde," in THE ARTIZAN for June 1st, we stated that, among others, the firm of Messrs. Lawrence Hill and Co., of Port Glasgow, had given in a tender. These gentlemen now inform us that "they did not offer for the gunboats at all, nor did they name any price, directly or indirectly," and we feel it our duty to rectify our statement in accordance with their desire.

THE "RUSSIA" screw steamer, built by Messrs. Thomson, of Govan, has just been added to the Cunard fleet. As the subsidy which has been paid to the Cunard Company for the British and North American Royal Mail Service shortly expires, this vessel is to be the last of the line of steamers specially constructed to perform that service. The *Russia* has 348ft. in length, 42ft. beam, 29ft. depth, and a registered tonnage of 3,141 tons; her engines, constructed also by Messrs. Thomson, are direct-acting, and of 650 h.p. nominal. Her trial trip took place at Wemyss Bay, on the Clyde, on May 28th. She ran from the Clock to the Cumbaes in 55 minutes, against the tide, her engines making 56 to 58 revolutions per minute; this gave a maximum speed of 15 knots. On May 30th she arrived in the Mersey at 9 a.m., having performed the trip in 16 hours.

TELEGRAPHIC ENGINEERING.

INDIAN TELEGRAPHS.—Colonel Glover, the temporary head of the Indian Telegraph Company, states in his report that in December last the percentage of serious errors in 29,968 Indian messages was only a quarter, and of trivial errors 2¼, while in 1,978 Indo-European messages it was 9⅓, of which 1⅓ were serious. Since 1850, when the first wire was laid,, the telegraph has cost £1,218,443 of working expenses, in addition to £1,345,328 of capital. Allowing for free messages sent by officials, the revenue has been £708,887, showing a loss of more than half a million sterling, besides the interest on capital. In a few months we are promised a special wire for Indo-European messages between Kurrachee and Bombay, if not between Bombay and Calcutta. The Viceroy pronounces all this "not wholly unsatisfactory."

THE TASMANIAN SUBMARINE CABLE.—The Telegraph Construction and Maintenance Company are now contracting with Captain Gilmore, an agent of the Government of Tasmania, to manufacture a cable which is to join that island with Australia. It is to be submerged in Bass's Straits, the breadth of which is about 200 miles, and the depth about 45 fathoms. The Tasmanian Government have granted a guarantee of 6 per cent, which is always to be payable wholly or partly, so long as the receipts of the line fail to give 10 per cent on the capital invested. The concession is for 20 years, and is given under most favourable and untrammelled stipulations. It is expected that the work will be completed in January, 1868.

DOCKS, HARBOURS, BRIDGES.

HARBOURS OF REFUGE.—The total cost of works connected with harbours of refuge throughout the United Kingdom for the year 1867-68 is estimated at £106,100. Of this sum, £28,500 is required to extend the pier head at Dover and to insure the safety of the existing structure; £42,200 for works at Alderney, and £6,000 for the harbour at Portland. A sum of £29,400 is required for works at and about Holyhead, of which £27,000 will be employed in the construction of the harbour, £1,493 for the harbour-master's department in connection with the packet service, £682 for Portpatrick harbour, and £300 for the works at Spurn Point.

THE HUTTON IRON GIRDER VIADUCT on the Scarborough and Whitby line was opened on June 1st. This viaduct carries the York and Scarborough Railway from the North to the East Riding obliquely across the river Derwent, three miles below Malton. It has stone and brick piers, and reversed iron girders, on the top of which the permanent way is laid. The various spans vary from 90ft. to 100ft. The whole of the summer traffic will have to pass over this viaduct.

RAILWAYS.

RAILWAYS IN ITALY.—The Civita Vecchia and Nanziatella line, which is to unite the Leghorn line to Rome, via the Maremme marshes, is now ready for traffic. The various bridges over the rivers Mignone, Marta, Arone, and Fiera, were built under the direction of Mr. Balthelemy.—The total mileage of the Italian railways amounts at present to 2,752 miles; of these, 404 were opened in 1866. The whole length of the East Coast Railway, from Lecce to Ancona and from Ancona to Bologna and Ferrara is now in operation. It is to be carried further South as far as Otrauto, whilst the proposed lines between Ferrara, Rovigo and Mantua, and between Mautua and Cremona are intended to connect the East-Coast lines with the North Western net north of the Po, and also with the Austrian lines. The connection between Bologne and Turin, south of the Po, has been in active operation for some years past.

MILITARY ENGINEERING.

A FIFTEEN-INCH RODMAN GUN, cast at Boston, has recently been bought by the British Government, in order to test practically the powers of ordnance of this nature in the attack of iron-clad structures. This gun weighs 19 tons 4cwt. 2qr.. and has a preponderance of 6cwt. 1qr. The length of the bore is 14ft. 6in. The external diameter at the thickest part of the breech is about 4ft., and at the muzzle 23in. The thickness of metal round the charge is about 16in., and behind the charge about 21in. The form is very similar to the Dahlgren gun, and there are no unnecessary rings or mouldings. There are two vents, one on each side of the vertical plane passing through the axis. The method of elevation is peculiar. A long screw passes through the cascable, its end resting on the platform, and the gun is elevated or lowered simply by turning the screw by a handle at the top, when the cascable, acting as a nut, rises up or descends the screw. The shot weighs about 450lbs. The charge intended to be used against iron-clads is 50lbs., but officers commanding ships are permitted to fire 20 rounds with 60lb. charges in attacking iron-clads. The ordinary service charge is 35lbs., and it was with this charge that, during the late war, a 15-in. cored cast iron shot, weighing 430lbs., went completely through the armour of the Confederate iron clad *Atlanta*, at its encounter with the U.S. Monitor *Weehawken*. This armour, however, consisted only of rolled plates of 4½in thickness, backed by yellow pine. It remains to be seen whether, even with 50lbs. of powder, a similar feat can be accomplished on a 4½in. solid plate, backed with teak, such as forms the *Warrior* target.

MINES, METALLURGY, &c.

MINING IN CORNWALL AND DEVON.—The following statistics have been collected with reference to the number of mines that have stopped working in Devon and Cornwall, and the number of miners who have emigrated during the depression in mining from which the two counties are now suffering. The mines which have been "knocked" number nearly 300, the great majority being in Cornwall. The emigrants from the various districts have been:—Tavistock and Ashburton, 691 men; Liskeard, 100 men; St. Austell and St. Blazey, 275; Redruth and St. Agnes, 300 men; Camborne, 150; Hayle, 550; St. Ives and Lelant, 150; St. Just, 600; Helston and Wendron, 100; Marazion and St. Erth, 450; total, 3,366. These are all able-bodied men, and the most skilled and active of the mining population. Adding to these the wives and families of the miners who have also emigrated, some idea may be formed of the great extent to which the population of the mining districts of the west of England has been thinned.

BISMUTH.—A discovery has recently been made in South Australia of a lode of bismuth and samples of the metal are now to be seen at the Melbourne Exchange, to which place they have been sent from the neighbouring colony. This metal is very valuable if found in quantity, and it is stated that the lode discovered contains abundance of rich stuff, but being situated about 200 miles in the interior, some serious difficulties in the cost of carriage have been encountered. Trouble was also experienced in getting the meta smelted, but a quantity of it was sent to England in ingots some time ago, and it is exl pected the supply will be kept up.

GAS SUPPLY.

THE METROPOLITAN GAS BILL (the chief features of which we explained in our issue of May 1st), having passed its second reading, is now in the hands of a special committee of the House of Commons. It is to be expected that the most objectionable clauses will be so modified as to satisfy the interests of the public, without injuriously affecting the rights of the companies guaranteed by previous acts. The principles to be embodied in the new act, and upon which the Government insists, are:—That effectual penalties for supplying improper gas shall really fall on the companies, and not on the consumer; that if circumstances change, there shall be a means of varying the standard price of gas, either upwards in favour of the companies, or downwards in favour of the consumer, as the case may be; and that for the present rule, which limits the maximum profits of the companies to 10 per cent, and thus destroys all motive for exertion, there shall be substituted a sliding scale, of which the lowest point shall be the actual present profits of the companies, calculated on an average of a certain number of years, and which shall be capable of rising indefinitely in proportion as the price of gas is lowered.

WATER SUPPLY.

DISEASES PRODUCED BY VEGETABLE ORGANISMS.—Professor Haunon, of the University of Brussels, has lately proved that the spores of some species of fresh water algæ, at th period of their fructification, are capable of producing intermittent fever; and the observations and researches of several eminent medical authorities lead to the belief that many other diseases to which the human frame is liable, have their origin in the vegetable organisms which abound in water. Some of the spores are probably thrown off into the atmosphere, and, being drawn into the lungs, are absorbed by the blood, but by far the larger portion doubtless find their way into the stomach, and so give rise to disorders of the alimentary canal. Their tenacity is said to be so great, that the temperature of boiling water is insufficient to destroy their vitality, and even beer and bread, notwithstanding the heat to which they have been subjected, in many cases show abundant evidence of the existence of these algæ. These facts furnish a strong proof of the necessity of filtering water, whether required in large quantities for the manufacture of food or in smaller quantities for domestic purposes, and we have much pleasure in calling the attention of our readers to a mode of filtration which appears to furnish the best possible safeguard against the evils above described. The Main Service Filter, manufactured by the Silicated Carbon Filter Company, can be adapted to the supply-pipe of a brewery, distillery, or manufactory of any description, and thus purify all the water before entering the building. The value of such a method of purification will be appreciated by those who have ever seen the inside of a large cistern after having been used for some time without cleaning. The quantity of vegetable matter which covers the sides of such a cistern is astonishing, and one cannot wonder at disease being propagated by water kept in such a receptacle. Mere straining of water through animal charcoal is not sufficient to stop this vegetable matter, but the principle of the Silicated Carbon Filter is the employment of a porous slab cemented into a filtering vessel, an arrangement which effectually prevents the passage of any extraneous substance.

THE CITY OF VALPARAISO is to be supplied with water through a canal to be cut from the Aconcagua River, flowing from the Andes Mountains. This canal, a portion of which has already been completed, is at the same time calculated to yield a revenue for supplying irrigation water to the lands throughout its course. With a view to effect these objects, a "Valparaiso Waterworks Company" is now being started in London, with a capital of £200,000, in shares of £20.

PESTH WATERWORKS.—The municipality of Pesth have just contracted with Mr. G. E Peters for the supply of water to that city. The works are to be erected on a piece of ground abutting on the Danube, near Neu-Pesth, about six miles from Pesth. Here the water will be pumped up from the river, filtered and conveyed to a rising ground behind the largest suburb, whence it will supply the whole town, a pressure of 100ft. being obtained for that purpose. The total cost of the carrying out of this scheme is estimated at £250,000. The concession granted to Mr. Peters is for a period of ninety years, at the expiration of which the works are to become the property of the town of Pesth.

APPLIED CHEMISTRY.

CARMINIC ACID (C = 12), when boiled with dilute sulphuric acid, splits into carmine red and sugar; the latter reduces Trommer's solution, and gives Pettenkofer's reaction. but neither ferments nor acts on polarised light; traces of it are dissolved by alcohol, Dried at 50°, its formula was—

$$C_6 H_{10} O_5 \text{; at 100, } C_6 H_8 O_4.$$

Carmine red, $C_{11} H_{12} O_7$, is a dark purple amorphous substance, reflecting green light, soluble in water and alcohol, with a fine red colour; insoluble in ether. Like carminic acid, it pertinaciously retains traces of phosphates; its alcoholic solution, when treated with alcoholic potash solution, deposits the whole of the carmine red as $C_{11} H_{10} K_2 O_7$, from which the corresponding baric and calcic compounds were obtained. Powerful reducing agents perfectly decolourise the solution of carmine red, but the resulting body could not be separated in a pure state. Fused with potash solution of appropriate strength, carmine red gives oxalic and succinic acids, and coccinine—probably $C_{14} H_{12} O_5$ — a body resembling chinon. Its crystals polarise light, are insoluble in water, easily soluble in alcohol, difficultly so in ether. Coccinine dissolves very easily in dilute alkaline solutions, and in such solutions is one of the most sensitive bodies to the action of oxygen. The solution is at first yellow, then violet, finally a magnificent purple red. Few bodies give rise to so many phenomena of colour as coccinine. From the splitting of carminie acid into carmine red and sugar, perhaps Schützenberger's is the nearest to the real formula —probably $C_{17} H_{18} O_{10}$—of that much-investigated body.—H. Hlasiwetz and A. Grabowsky in the *Annalen für Chemie und Pharmacie*.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated May 3rd, 1867.

1291 H. W. Grylls, H. Neville, W. Brooks, and J. Holt—Obtaining motive power
1292 A. M. Clark—Locking screw nuts
1293 E. Krieghoff—Spring mattresses
1294 J. H. Johnson—Raw silk
1295 J. Heaton—Conversion of cast iron into wrought iron
1296 G. F. Millin and E. J. Potter—Parcel hooks
1297 J. Holmes—Beer engines
1298 S. Thacker—Knitted fabrics
1299 J. G. Rollins—Breech-loading revolving firearms
1300 J. Ramsbottom and T. M. Pearce—Turbines &c. for obtaining motive power
1301 T. Crossley—Portable lamps or illuminators
1302 T. Crossley—Giving alarm in cases of fire
1303 C. B. Reitz—Meters for measuring the flow of water and fluids

Dated May 4th, 1867.

1304 H. Allman—Bearings of axles of railway carriages, etc.
1305 R. Russell—Kitchen ranges
1306 J. Thevenet—Slide valves of steam engines
1307 L. Delperdange—Protecting underground telegraphic wires
1308 J. H. Johnson—Magneto-electric signal lights
1309 E. Leigh—Landing stages and iron ships
1310 J. Helmsley—Tubular fabrics in warp machinery
1311 T. W. Bunning and W. Cochrane—Getting coal
1312 H. A. Bonneville—Weeding apparatus
1313 N. M. Shafer—Binders for papers
1314 J. Baker—Generating electricity and applying it to produce motive power
1315 P. Brash and W. Young—Facilitating the burning of petroleum
1316 T. R. Crampton—Preparing clay, &c.

Dated May 6th, 1867.

1317 W. Bradbury—Stillages employed in packing and baling presses
1318 B. H. Smith—Papering needles
1319 P. Haenlein, J. Fisher, and R. G. Fisher—Telegraph posts
1320 J. Nadal—Portable fountain
1321 J. Ball—Bricklayers' and other trowels
1322 K. J. Winslow—Propulsion of carriages
1323 R. Taylor and E. Poulson—Securing the sheets of fore and aft sails
1324 W. Clark—Looms for weaving pile and other fabrics
1325 W. Schofield and E. Smith—Self-acting damper in connection with steam boilers
1326 W. R. Lake—Locks
1327 G. Wilson—Steel tyres, &c.
1328 G. Wilson—Construction of buffers
1329 T. Crow—Burning hydrocarbon oils
1330 J. H. Johnson—Lighting gas lamps.

Dated May 7th, 1867.

1331 S. E. Hallett—Capturing fish
1332 S. E. Hallett—Trawl nets
1333 S. E. Hallett—Capturing salmon, &c.
1334 J. S. Cavell—Automaton figures
1335 E. Bourdon—Regulating the flow of liquids
1336 G. Hartban—Communicating motion for any purpose
1337 J. Booth—Receptacles for containing and emitting oil, &c.
1338 R. Marsden and U. Bromley—Railway break
1339 W. W. Greener—Breech-loading firearms
1340 A. H. Gilman—Making, roving, and spinning yarn
1341 E. Faucher—Forming wooden hoops
1342 J. B. Blythe—Coating and ornamenting metallic or other surfaces
1343 R. Smith—Collars for horses &c.
1344 C. Burrell—Drawing and dressing seeds
1345 W. E. Newton—Explosive compounds and igniting the same
1346 W. R. Lake—Cleaning grain
1347 G. Krauss—Tenders for locomotives
1348 N. W. Wheeler—Hydraulic valve gear for steam and analogous engines
1349 N. W. Wheeler—Skylights and ventilators
1350 N. W. Wheeler—Slide valves, &c.
1351 N. W. Wheeler—Introduction of fluids to surface condensers of steam engines
1352 J. Crockatt—Securing the handles of doors
1353 H. J. Saxby—Locks and catches

Dated May 8th, 1867.

1354 J. Fairley and A. Fairley—Plantation and other hoes
1355 C. Layton—Producing parts of steam fittings
1356 C. D. Abel—Converting the gaseous products of combustion into combustible gases
1357 J. Gaskell—Building cops in winding machines
1358 W. R. Lake—Fastening for hoops
1359 J. Nixon and J. Winterbottom—Piercing and drilling tangs and scales for table knives and forks, &c.
1360 T. A. Weston—Actuating drills, &c.
1361 T. J. Mayall—Means employed in printing
1362 H. R. Cottam—Bedsteads
1363 G. E. Donisthorpe—Combing wool
1364 H. R. Cottam—Ornamental rails
1365 R. Wood and A. Wood—Treating paper

Dated May 9th, 1867.

1366 S. W. Worssam—Working wood
1367 A. Fournier—Toy boats or ships
1368 G. H. Cail—Preventing the explosion of steam boilers
1369 T. A. Weston—Springs for buffers and bearings
1370 G. Sims—Making waistcoats reversible
1371 J. Bowden—Water-closet tap
1372 M. Fleming—Washing bottles
1373 T. A. Weston—Friction coupling breaks
1374 T. Brown—Egg beater
1375 T. Brown—Coffee pot
1376 A. Herce—Pianos
1377 W. E. Newton—Welding iron and steel
1378 W. E. Newton—Lubricating the stuffing boxes of steam engines and pumps
1379 R. Andrew—Communicating between passengers in railway carriages and the guard and driver of railway trains, &c.
1380 C. Ritchie—Casks, &c.
1381 G. Jeffries—Closing central fire sporting cartridges

Dated May 10th, 1867.

1382 G. McKenzie—Illuminating gas
1383 F. B. Doering—Rotary engines
1384 W. Bracewell, W. Pickup, and B. Lund—Valves for steam and other fluids
1385 R. Mellard—Preparing and mixing food for pigs and other animals
1386 J. Norman and W. Hay—Flour
1387 A. Cooper—Single and double box pickers for looms
1388 C. Jones—Coal mining machinery
1389 J. Johnson and A. Giles—Drying yarns
1390 C. H. Trask—Governors for engines
1391 J. Combe—Winding cops and working from cops
1392 W. Smyth—Navigating the air
1393 W. Clark—Brick-making machines

Dated May 11th, 1867.

1394 C. Marlow—Cases for clocks
1395 J. A. Knight and C. Bastand—Feed bag for horses
1396 J. Reilly—Mechanical aids for enabling swimming, &c., to be rapidly acquired
1397 J. Walker—Scales and beams for weighing purposes
1398 G. F. Russell—Rotary engines
1399 G. Browning—Button hole sewing machines
1400 J. Piddington—Boring gun barrels and ordnance
1401 J. Steven—Gauges for steam boilers
1402 T. Nelson—Cards, tablets, &c.
1403 W. Clark—Bleaching textile fabrics
1404 J. Watkins—Axles for carriages
1405 J. W. Dalby and P. Constantine—Species of yarns
1406 W. L. Lake—Caster for furniture
1407 W. R. Lake—Constructing metal cocks

Dated May 13th, 1867.

1408 G. A. Neumeijer—Gunpowder for mining purposes
1409 J. G. N. Alleyne—Puddling furnaces
1410 R. H. Padbury—Shuttle for sewing machines
1411 G. Lunge—Preparation of ores
1412 H. A. Bonneville—Washing powder
1413 J. Leetch—Cartridge holders
1414 C. Eastwood—Looms for weaving
1415 W. Cormack—Revivification of animal and vegetable charcoal
1416 W. E. De Bourrau—Concentrating saccharine fluids
1417 J. Butler—Construction of armour plated ships and batteries
1418 M. D. Rogers and J. Wilson—Fire engines
1419 E. Field—Generating and condensing steam
1420 J. Clark—Railway breaks
1421 W. Sodo—Improving and refining liquors

Dated May 14th, 1867.

1422 A. H. Culles—Signalling between passengers, guards, and engine drivers upon railways
1423 C. Randolph—Propelling vessels
1424 B. Barrett and H. Mackenzie—Egg boilers for the table
1425 J. J. Bastin and L. A. Boum—Perpetual motion
1426 J. G. Jennings—Water closets and sinks
1427 A. M. Clark—Raising liquids
1428 E. Walker—Windlasses
1429 A. V. Newton—Axle boxes and bearings

Dated May 15th, 1867.

1430 J. C. Ellison—Removing the cardboards, &c. from the folds of fabrics used in pressing
1431 C. Brazil and R. Grime—Wetting and drying yarns
1432 H. C. Baildon—Nature printing from natural objects
1433 E. Smith—Obtaining violet colouring matter
1434 F. Boney—Ships and boats
1435 C. Perry—Flattening buckle pins in machines for combing fibrous substances
1436 W. Clarke and E. Walker—Raising or moving heavy weights
1437 W. D. Tate—Stopping bottles
1438 J. Johnson—Submarine tongs
1439 G. Nimmo—Metal wheels for vehicles
1440 A. V. Newton—Billiard tables
1441 G. Coles, J. A. Jaques, and J. A. Fanshawe—Wheeled carriages
1442 G. Coles, J. A. Jaques, and J. A. Fanshawe—Permanent way of railways
1443 E. Edwards—Treating mineral substances

Dated May 16th, 1867.

1444 J. Harper—Single cylinder printing machines
1445 P. A. De Berenger—Burning lime, &c.
1446 C. Robert—Breech-loading firearms
1447 J. M. Napier—Printing machinery
1448 G. T. Bousfield—Illuminating gas
1449 J. H. Johnson—Breech-loading firearms
1450 G. F. Harrington—Marine baths
1451 C. E. Brooman—Sewing machines
1452 J. Griffiths—Sowing seeds, &c.
1453 J. Sadler—Nail cutting machine
1454 J. M. Stanley—Blast and other furnaces

Dated May 17th, 1867.

1455 J. Deuis—Treatment and preparation of fibrous substances for the manufacture of paper
1456 F. P. Warren—Tobacco pipes
1457 H. Peel—Looms for weaving
1458 P. M. Parsons—Artificial granite &c.
1459 A. Angut—Spring petticoat
1460 H. Hollingsworth—Shoe for piles
1461 A. L. Dowie—Treating iron
1462 J. Smith—Driving sewing machines
1463 W. R. Lake—Water gauges for steam boilers
1464 W. R. Lake—White lead
1465 W. R. Lake—Producing chloride of lead
1466 G. Bernhardt—Throstle and doubling frames and machines for spinning, twisting, and doubling fibrous materials
1467 S. Regan—Marine and land boilers and their furnaces
1468 E. Webb—Looms for weaving
1469 A. V. Newton—Lowering, detaching, and picking up ships' boats
1470 C. E. Brooman—Calculating apparatus
1471 J. L. Clark—Communicating between the passengers, guards, and drivers of railway trains

Dated May 18th, 1867.

1472 T. Richardson—Extraction of oils from vegetable substances
1473 J. Sloan—Ships' water closets
1474 J. T. Bland, E. J. Blood, and T. Brevetor—Regulating the supply of fluids to cisterns, &c.
1475 C. P. Button—Hernia trusses, &c.
1476 B. Shell—Paving for roads and quays
1477 A. H. Brandon—Washing wool
1478 H. A. Dufrené—Transferring heat from one current of gas to another
1479 C. W. Dixon—Slide valves
1480 J. Smith and J. L. Ibbotson—Raising and lowering revolving shutters
1481 J. White—Binder for sewing machines
1482 E. O. Hallett and W. T. Hallett—Book rest
1483 G. Haynes—Cleaning boots and shoes
1484 W. E. Gedge—Novel system of cartridge
1385 J. L. Norton—Drying malt
1486 J. L. Norton—Washing and drying wool, &c.

Dated May 20th, 1867.

1487 T. Metcalf—Burning hydrocarbon oils
1488 J. Bottomley—Looms for weaving
1489 T. McComas—Raising sunken vessels
1490 H. A. Dufrené—Beer and other engines
1491 A. M. Clark—Sharpening cutlery
1492 C. D. Abel—Machine for filling sacks
1493 E. H. C. Monckton—Preserving meat, &c.
1494 H. Chamberlain—Steam boiler and other furnaces
1495 J. G. Tongue—Furnaces for steam boilers
1496 E. Bond—Ships' sail yards
1497 V. Barford and J. Skermon—Boilers for boiling roots, &c.
1498 E. Young—Treating iron ores to remove phosphorus therefrom
1499 W. M. Cranston—Reaping and mowing machines
1500 D. Thomson—Steam rollers for rolling roads

Dated May 21st, 1867.

1501 J. Owens—Pile and other fabrics
1502 J. Davies—Folding sheets of paper, &c.
1503 E. H. C. Monckton—Steam vessel suitable for ferrying laden trains across the ocean complete
1504 J. Gough—Producing devices on the covers of books, &c.
1505 M. Runkel—Indicator for carriages
1506 G. Hurdman—Charcoal box irons
1507 W. Nichols, J. Burnley, T. Wilson, and G. Jackson—Cutting flax, &c.
1508 S. Holt and G. Holt—Improvement in pickers
1509 C. H. Sharnham—Self acting and ink supplying apparatus
1510 S. H. Foster and T. Bunney—Looped fabrics
1511 W. F. Henson—Rails for railways
1512 J. Stenhouse and J. Duncan—Treatment of animal charcoal
1513 A. Barclay—Injecting and ejecting liquids and fluids
1514 A. V. Newton—Central fire metallic cartridge
1515 O. Wassermann and J. H. Herbat—Refining pig lead scraped by means of reguline zinc
1516 J. Mabson—Sewing machines

Dated May 22nd, 1867.

1517 D. Adamson—Heating the air stoves of blast furnaces, &c.
1518 J. Collins and J. Smethurst—Dressing hides
1519 J. Cartland and Henry Bold—Ornamenting certain kinds of bowls of castors for furniture
1520 J. Hargreaves and T. Robinson—Manufacture of steel and soft iron from cast iron
1521 W. J. Murphy—Breech-loading firearms and cartridges
1522 R. S. Moss—Wearing apparel
1523 W. Brookes—Lubricator
1524 A. M. Clark—Fabric for machine belting, &c.
1525 J. M. Kauffmann—Means for travelling
1526 W. E. Newton—Portable photographic apparatus
1527 A. Martin—Preserving grain
1528 A. G. Hely and J. Marshall—Machinery for obtaining pressure
1529 E. W. Hughes and T. H. Head—Rotary engines and pumps

Dated May 23rd, 1867.

1530 F. H. Johnson—Gas blow pipes, &c.
1531 M. Theiler, sen., R. Theiler, and M. Theiler, jun.—Telegraphic instruments and electric clocks
1532 C. W. Siemens—Means for conveying articles through tubes
1533 M. F. A. Olmade—A table with double face and surprise
1534 A. M. Clark—Typographic printing machines
1535 E. Howell and T. Hardy—Root cutting machines
1536 S. Atkinson and T. Atkinson—Folding paper
1537 C. E. Brooman—Furnaces
1538 T. G. Green—Earthenware
1539 A. V. Newton—Feed water arrangement
1540 L. Stuckenschmidt—Discharging grain from ships, &c.

Dated May 24th, 1867.

1541 H. Blackham—Spectacle frames
1542 J. M. Muterse—Extinguishing fires by means of cartridges
1543 C. Martin and J. Grint—Railway buffers
1544 T. W. Helliwell—Looms for weaving
1545 G. M. Wells—Boots and shoes
1546 L. Slatter—Cases for packing dairy produce
1547 A. M. Clark—Steam generators
1548 G. Howard—Parquet flooring
1549 C. Sanderson—Melting of cast steel
1550 T. Greenwood—Boring metals in the solid
1551 G. T. Bousfield—Braiders to be used with sewing machines
1552 J. M. Napier—Serving mustard

Dated May 25th, 1867.

1553 J. Simpson—Producing photographic pictures.
1554 A. Oldroyd—Tobacco and other pouches
1555 A. M. Clark—Watered fabrics
1556 I. Baggs and F. Braby—Treatment and utilisation of certain ferruginous and calcareous salts and solutions
1557 W. Rylands—Tea pots, &c.
1558 W. Dutton—Furnaces for heating salt pans and for other purposes
1559 W. P. Struvé—Furnaces for calcining ores and metals

Dated May 27th, 1867.

1560 H. B. Barlow—Coupling pipes
1561 H. Frost, sen., and H. Frost, jun.—Measuring fluids
1562 W. P. Metchin—Taking copies of printed matters
1563 W. Affleck—Guard for wheels of reaping and other machines
1564 R. R. Knott and J. Jeyes—Preparing and adapting wood as a substitute for leather
1565 P. A. J. Dujardin—Electric telegraphs
1566 W. Snell—Stone dressing machines, etc.
1567 W. H. Whettem and E. Walker—Screw propellers
1568 J. C. Mewburn—Harvesting machines

Dated May 28th, 1867.

1569 H. Pether—Ornamental bricks
1570 M. Loam and F. H. Fearns—Optical instruments
1571 E. T. Hughes—Combined seeder, cultivator, and roller
1572 G. H. J. Simmons—Lamp for burning hydrocarbonic oils
1573 F. J. Vandenvinne—Clearing uncultivated land
1574 W. Coulson—Doors and door frames of furnaces
1575 H. A. Bonneville—Motive power
1576 H. A. Bonneville—Carding wool
1577 H. A. Bonneville—Weaving wool
1578 H. Cockey and F. C. Cockey—Dip pipes in connection with gas and other retorts
1579 T. F. Cashin—Compound lever
1580 W. Mitchell—Food for sheep
1581 L. H. Detbiou and F. Beaubry—Tongless buckle
1582 A. M. Clark—Machines for washing, etc.

Dated May 29th, 1867.

1583 D. Tunks—Galvanometers
1584 R. Pollit—Steam boilers
1585 W. J. Burgess—Fingers for mowing machines
1586 J. F. N. E. Simons—Preventing the incrustation of steam boilers
1587 C. Minasi—Trombonettes
1588 T. Mitchell—Felt carpeting
1589 F. J. Drean—Producing letters in gold
1590 J. R. Cooper—Cartridges
1591 J. M. French—Measuring spirits
1592 R. Newton—Furnace apparatus of steam boilers
1593 F. B. Gage—Photographic apparatus
1594 T. E. Passee—Obtaining motive power
1595 W. B. Ritchie and J. G. Willans—Drying peat
1596 H. Turner—Marine and other steam engines
1597 E. Jones—Safety lamps for miners
1598 A. V. Newton—Mosaic veneers
1599 W. E. Newton—Printing blocks
1600 T. Greenwood—Milling machines
1601 H. Oakes—Earrings

Dated May 30th, 1867.

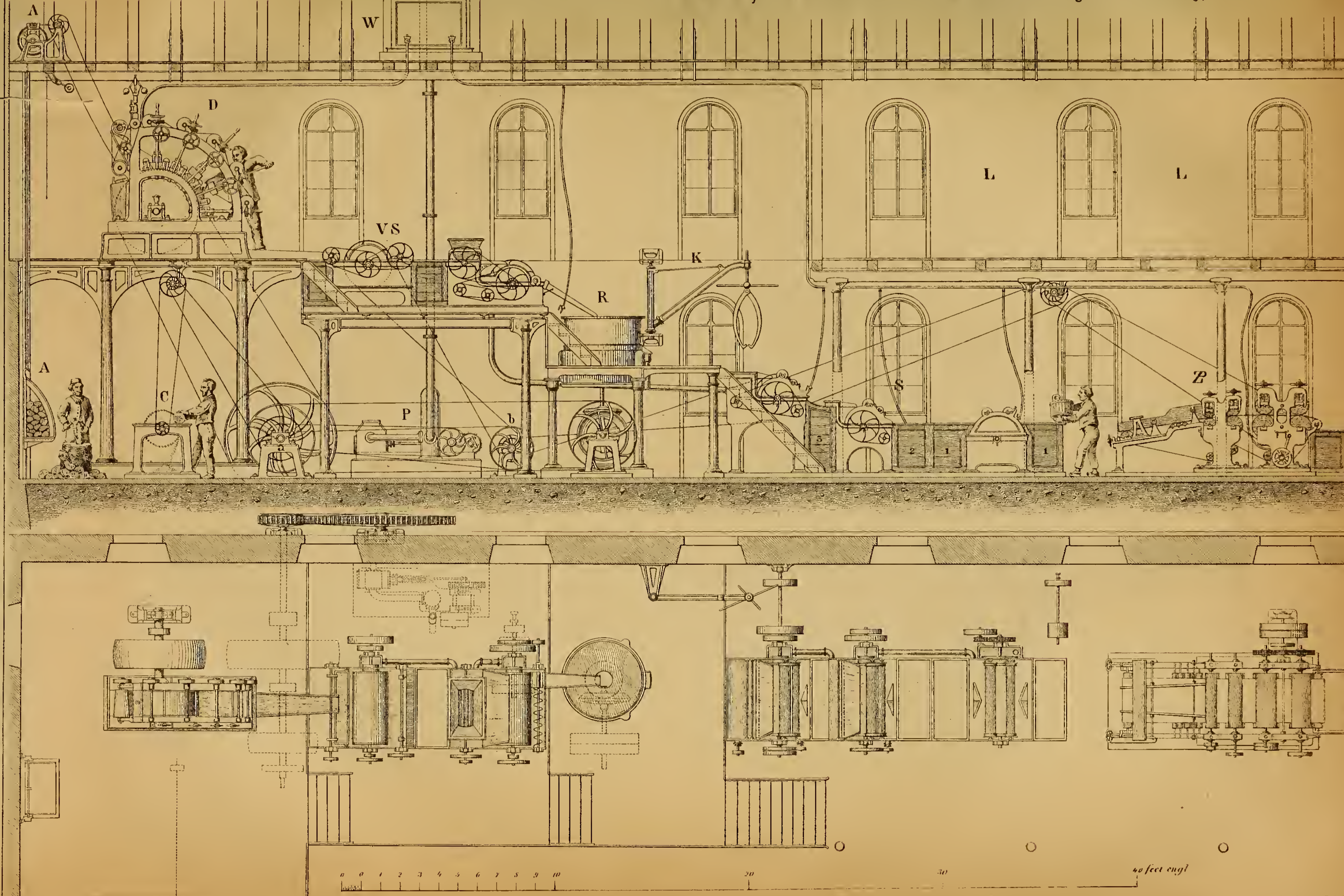
1602 H. Bain—Dyeing yarns
1603 C. E. Brooman—Photographic albums
1604 J. Francombe—Improved engine for obtaining motive power
1605 W. Orr—Separating moisture from substances
1606 J. Astbury—Casting metals
1607 W. Wood—Printed tapestry carpets
1608 W. E. Newton—Treatment of fabrics
1609 W. E. Newton—Felted fabrics
1610 T. Petitjean—Perfect combustion
1611 M. A. F. Mennons—Magneto-electric batteries
1612 W. R. Lake—Breech-loading firearms

Dated May 31st, 1867.

1613 F. J. Demsnet—Giving draught to any kind of chimney
1614 J. Scott—Subduing and extinguishing fires
1615 B. Shakespeare and W. Shakespeare—Reverberatory furnace
1616 J. Hinks and J. Hinks—Lamps for burning liquid hydrocarbons
1617 F. W. Dolmny—Obtaining an essential oil

Henri Voelter's Woodpulp machine

constructed by Decker brothers & Co. at Canstatt near Stuttgart. (Württemberg)



THE ARTIZAN.

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1st. AUGUST, 1867.

SPINNING MACHINERY AT THE PARIS EXHIBITION.

(*Continued from page* 147.)

In the Algerian department some effective cotton gins are exhibited by Mr. Chaufourier, of Paris. They are adapted for spinning and cleaning any kind of cotton, whether it be long or short staple. The cotton is drawn between two steel rollers working in contact, so as not to allow the passage of the smallest seeds, which drop through a grating in front of the rollers. The drawing process is contrived by a pair of leather-covered rollers, so as not to allow any cotton to be wrapped round the first. The rollers are cleaned by means of another pair of rollers at the back, covered loosely with leather, as the first. The chief novelty introduced in this machine is a small fan, which sends a current of air on the rollers, and tends to keep them cool.

We now pass on to the Belgian Department, where M. Celestin Martin, of Verviers, exhibits a machine for opening and oiling the fleece. This machine is provided with a self-feeding apparatus, somewhat similar to that described previously in connection with M. Mercier's machinery. The wool is opened by a beater with iron blades, and passes on a travelling lattice to the oiling apparatus, consisting of a trough containing the oil, which is slowly and regularly tipped over by a necessary arrangement of gearing, so that the requisite quantity of oil is poured out on to a revolving brush, which sprinkles the wool, as it passes under, towards a drum covered with short steel points, and the wool is delivered thus in a fit state for carding.

The same maker exhibits a set of three carding machines. The "scribbler" is provided with a self-feeding apparatus, the fleece is stripped from the doffer and formed into a sliver, which is wound into a ball. Forty of these balls are placed in a creel, to supply the "intermediate" card, and a sliver twice the size of the former is stripped from the doffer and wound into a ball. This sliver serves to supply the "condensor" in a novel manner. The end passes through an eye or guide, which is made to traverse free, and in this manner the sliver is folded backward and forward on the feeding rollers. The fleece thus formed is divided into parallel strips by thin steel blades, which are stationary between the carding cylinder and the doffer; the 64 strips and two wasters are then felted by passing between two endless bands of leather stretched on pairs of rollers having an alternate transverse motion, and are wound upon rollers. This machine works about 150lbs. per day.

Messrs. Hodget and Teston, of Verviers, besides supplying motive power to the Belgian and Prussian sections, have a good show of wool-preparing machinery, consisting of burring and opening machines, with apparatus for oiling the fleece previous to being carded. The "lap" or fleece formed by this machine is rolled continuously on a cloth, which effectually protects it from any damage, and at the same time from the evaporation of the oil. The "scribber" card is 44ins. in width, with five pairs of workers. The feeding-table is so arranged as to take a "lap" whilst the cloth is wound upon a roller underneath as the "lap" is taken in. The fleece is stripped from the doffer, and formed into an endless sliver, which passes along an endless cloth, to supply the finisher carding machine by means of an "Apperley and Clissold's Feeder."

M. Richard Hartmann, of Chemnitz, Saxony, exhibits some carding machines for wool, a self-acting mule adapted for spinning fine numbers, having 180 spindles of 1¾in. distance, and several machines for the preparation and spinning of flax and hemp.

In the Austrian Department, Mr. Girardoni, of Vienna, exhibits a double carding machine adapted for cotton, the peculiarity of which consists in placing the carding cylinders one over the other, instead of side by side, as it is usually done. By this arrangement a great economy of floor space is gained. The workers and clearers are placed round nearly the entire circumference of the carding cylinder, the space through which waste can be thrown being thereby reduced. The fleece is delivered from the first or "breaker" cylinder to the "finisher," which is surrounded by a pair of rollers and breaker, and six smaller rollers underneath. The doffer is stripped in the usual manner by a vibrating comb, and the sliver thus formed is coiled in a revolving can. The production is stated to be from 150lbs. to 220lbs. per day, and the waste is exceedingly small as compared with other machinery, being only from four to five per cent. of the raw material used, fly, combings, and strapping included.

The largest display of cotton machinery in the whole Exhibition is that of Messrs. Rieter and Co., of Winterthur, in the Swiss Department. It consists of an opening and cotton-cleaning machine, and a lapping machine. The process of double carding (that is to say, carding in two carding machines only, the first a "breaker," and the second a "finisher") with the intermediate process of "lap-doubling," is shown. The "breaker" carding-engine is provided with six workers and cleaners. The fleece is stripped from the doffer in the usual manner by a vibrating comb, and drawn through a tube into a "sliver" by a pair of fluted rollers, and finally delivered and coiled in a revolving can. The lap doubler is for the purpose of laying the slivers from the "breaker" side by side, and forming them into a "lap" to supply the "finisher card." Twenty-four cans containing the slivers are arranged on one side of the machine, each end passes through a guide provided with a self-stopping motion, so that in case any sliver should break the machine is stopped, which prevents waste or spoiled work. The slivers then pass between two pairs of callender rollers, and the "lap" thus formed is wound on a light wooden bobbin placed in the channel between a pair of fluted rollers. Four of these laps placed end to end form a complete lap for the "finisher" card. This machine is mounted with twenty-four self-stripping flats on Wellman's system. The fleece is removed from the doffer in the usual manner by a vibrating comb, and formed into a sliver, which is coiled in a revolving can.

Messrs. Rieter also exhibits a drawing frame, a slubbing frame of 40 spindles, an intermediate frame of 72, and a roving frame for 80 spindles, of excellent workmanship. They also show a self-acting mule for spinning fine numbers.

Some well-constructed "silk-throwing" machinery is exhibited by Messrs. Wegmann and Co., of Baden (Argau), consisting of:—

1st. A winding machine for winding off the skeins as imported, and cleaning the silk at the same time, by passing between steel cleaners.

2nd. A doubling machine for winding and laying evenly together on the same bobbin two or more threads; this machine is provided with an ingenious arrangement for stopping the bobbin, should a thread break.

3rd. A throwing machine for spinning warp, and another for spinning weft; and

4th. A machine for spinning sewing silk.

In the Italian Section some well-made machines are exhibited for silk winding, which, however, do not present any novelty in construction.

The contributions from the United States are rather scanty, and consist entirely of preparing machinery for cotton and wool, for which no special novelty can be claimed.

Mr. H. L. Emery, of Albany (New York), shows an 18in. and 40in. saw gin. The circular saws are mounted on a cylinder about an inch apart, and project about half an inch through a grating in the hopper or box into which the cotton is fixed; in front of these saws in the hopper there is a light wooden shaft, thickly studded with pointed wooden teeth. The saws are cleaned of cotton by a cylindrical brush revolving in a contrary direction, which at the same time creates a strong draught. Across the discharging side of the gin is placed a hollow cylinder of perforated zinc, through which the current of air caused by the brush passes, carrying with it the dust, which passes out at the ends.

The Southern Cotton Gin Company, of Bridgewater, Massachusetts, show a 60 saw gin with brush cylinder.

Mr. Goddard, of New York, exhibits what he calls a "Mestizo-burring picker," in which the wool is beaten and shaken till all the burrs fall out. The wool fed in on an endless lattice is taken between two rollers covered with hook-shaped teeth, and passes to the beater cylinder covered with bars and small teeth, making about 400 revolutions per minute; from this it is delivered to a smaller cylinder, covered with Garnet's cards, making about 550 revolutions per minute; the wool is cleaned from this by a cylindrical brush, making 990 revolutions per minute, and oiled by passing under a revolving brush upon which oil is constantly dropped. The dust is extracted from the wool through the perforated zinc casing over the cylinder by the aid of an exhausting fan draught. The production is stated to be 1,000lbs. per day.

The spinning machinery is well represented in the English section by

Messrs. Platt and Co., of Oldham, who exhibited a complete set of machinery for preparing and spinning cotton and wool, for which they have obtained a gold medal. For separating the cotton from the seed they exhibited three Macarthy gins. The principal feature in these gins is a roller, about four or five inches in diameter, built up of the fibres of jute in the same way as a brush and compressed so as to nearly resemble pasteboard. This roller revolves in front of a hopper, into which the cotton to be cleaned is thrown; the bottom of this hopper is made of wire-grating, sloping towards the roller. A thin steel plate is placed in front of the roller and presses gently against it. The fibres are seized and drawn under this plate by the revolving action of the roller until the seeds come in contact with it; a vibrating knife then ascends, and, passing the edge of the plate, pushes off the seed, which falls into the grating; the fibres thus freed are delivered on the other side.

The cotton is then spread upon the endless-feed lattice of the scutching machine, and taken to within range of a beater revolving in a casing fitted with a series of parallel blades; in this manner the cotton is opened and freed, to some extent, of the dust which falls through slits between the blades. It then passes to a series of drums covered with wire gauze, through which the remaining dust is drawn by the partial exhaustion of the air by means of a revolving fan. The cotton is stripped from the drums by a pair of iron rollers, and formed into a "lap" by passing between two pairs of callender rollers, where it is slightly felted by the pressure.

Two carding machines are exhibited by this firm, one 45½in. in diameter, with six pairs of working rollers. This is more particularly adapted as a single carder for coarse numbers, or as a "breaker" for preparing slivers for the "finisher."

The other is also 45½in. in diameter, fitted with one pair of working rollers, and an endless chain of self-stripping flats. This is especially suited as a finisher for cotton of five numbers.

A combing machine is also shown for laps of cotton, 16in. in width. A pair of nipping jaws takes a tuft of cotton from the lap which is placed on a roller at the top of the machine; it is next held by the jaws against a revolving comb, which combs out the short fibres. Both ends of the tuft are combed and deposited on a doffing cylinder in such a manner as to overlap each other, and to be reunited in a continuous sliver, which is afterwards deposited in a coiling can on one side of the machine.

The drawing, slubbing, and roving frames of these makers are of the usual construction.

Two self-acting mules, one for spinning cotton, and the other for wool, are shown at work. These machines are of the most improved construction, the cam shaft is driven by conical frictional pullies, a patent governor or cop regulator is attached for the purpose of adjusting the winding on motion to the form of the cop, which is perfectly automatic in its action. The drawing out motion is provided with an arrangement for stopping in case of obstruction to the free traverse of the carriage, thereby preventing breakage of bands, and other damages.

A throsle-frame is also shown, in which the common flyer is replaced by the ring and follower. It produces more yarn with the same number of spindles than the mule, as they can be driven with a greater speed, but the twist is not so regular.

Messrs. Lawson and Sons, of Leeds, have also obtained a gold medal for some important machinery connected with the preparation and spinning of flags. The carding machine is of considerable weight and importance, the main cylinder, or "swift," as it is sometimes called, being 5ft. in diameter, 6ft. in width, surrounded for the greater part of its circumference by working rollers and three doffers. The tow is supplied on an endless feed cloth, and the slivers are delivered into three coiling cans.

Some other well constructed machinery is exhibited by this firm, such as drawing frames, spreaders, roving frame of 72 spindles, and a spinning frame of 200 spindles.

Some excellent flax machinery is shown by Messrs. Combe and Co., of Belfast, consisting of hackling machine, roving frame with 50 spindles and self-acting yarn reel. The sheets of the hackling machine are vertical, the hackle stocks are fixed on the sheets instead of on bars, and in this manner run more lightly and with less noise and vibration.

The principal feature in the roving frame is the use of the expanding pulley in place of the conical drum for varying the speed of the bobbin, as the thread is wound. This ingenious contrivance for obtaining a variable speed is the invention of Mr. Combe, and consists of two interlocking cones, and in the groove thus formed the driving belt runs. By the parting or bringing together of these cones by means of an arrangement of right and left-handed screws, the diameter of the working groove is varied, and consequently the speed of the bobbins; a steadier motion is thus obtained than by the conical drum, a matter of great importance for the long fibres of flax slivers.

Some ingenious machinery is exhibited by Messrs. Wren and Hopkinson, of Manchester, for winding sewing silk on cards, and cotton on reels.

Mr. Ferrabee exhibits his patent improved machinery for carding wool, constructed by Mr. Tatham, of Rochdale. The fleece is taken from the doffer of the first or "scribbler" carding machine, by means of a system of endless cloths one working at right angles to the other, the fleece by this means is deposited in diagonal folds crossing each other alternately, on an endless apron running at right angles to the axis of the carding machine, and forming a continuous narrow fleece about 12in. in width, which is carried forward mechanically and laid without stretching in diagonal folds, one overlapping the other, in a continuous and uniform "bat" of the required thickness on the feed-lattice of the "condensor." In this machine, the fleece is divided into a series of parallel strips which are felted by passing between two endless bands of leather having an alternate motion across the threads, which are wound upon rollers one placed above the other.

WOOD PULP MACHINERY AT THE PARIS EXHIBITION.

(*Illustrated by Plate* 318.)

In the Wurtemberg Annexe, a building 82ft. in length by 40ft. in width, Messrs. Decker, Bros., of Canstadt, have obtained a gold medal for some highly important machinery for producing pulp from wood suitable for paper making. This machinery, the invention of, and patented by Mr. Henry Völter, manufacturer of paper, Heidenheim, is driven by three portable engines of the united power of 50 horses, by Mr. Calla, of Paris.

Many trials have been made of late years to produce a cheap substitute for rags for paper making from various fibrous substances, and wood seems to be the most suitable for this purpose, as uniting all the requisite qualities.

Pine and fir wood give the best pulp, having the greatest felting power, whilst aspen and lime wood produce the whitest pulp. Many other kinds of wood are suitable, such as the Scotch fir and the poplar, and even beech and birch wood, though producing a fibre much shorter, are extensively employed in Belgium.

No suitable means have yet been found for bleaching wood pulp to fit it for the manufacture of the finer qualities of paper, but its great felting properties, cleanliness, and comparative cheapness, make its large use in the manufacture of middling and common papers highly advantageous, thus leaving rags chiefly for the finer and more expensive sorts of paper, which is another great advantage.

In comparing the price of wood pulp with that of rags, the price of raw rags only should not be taken into consideration, as wood pulp represents finished pulp, which only requires mixing with finished rag pulp in order to make paper; while raw rags require to undergo several expensive processes to fit them for use. Therefore it is not the price of raw rags, of which about 2 cwt. are required for 1 cwt. of finished pulp, but the price of finished rag pulp that is to be compared with that of wood pulp. Wood pulp is mixed with rag pulp for the manufacture of paper in quantities from 15 to 80 per cent., according to the quality of the paper. Some excellent samples of paper are exhibited, for which they have obtained a silver medal, containing from 15 to 50 per cent. for middling writing, printing, and common letter paper; 50 to 70 per cent. for common writing, printing, and wrapping papers, 50 to 80 for paper hangings and cardboards, and even paste board made entirely from wood pulp.

As an ingredient for printing papers it is of great use; it remedies the too great transparency of thin papers; it takes the printing ink well, and shows a clean impression, the type does not get worn out so quickly as when papers made from straw are used. Papers for paper-hangings are improved by a mixture of wood pulp, as they take the colour more freely.

The machinery exhibited by Messrs. Decker consists of four principal parts.—the "defibrer," or grindstone by which the wood is reduced into fibre; the coarse sorting apparatus; the refiner and a sorting apparatus. These parts may either be placed in line, as in drawing, which would require a building 63ft. long, 16ft. 6in. wide, and about 20ft. high, or arranged otherwise to suit a building already existing.

The "defibrer" D consists of a grindstone about 4ft. in diameter and 16ft. in width, revolving in a cast iron casing, while water is continually flowing over it. This casing is divided into five rectangular chambers the width of the stone, and from 6in. to 8in. in depth, fitted with pistons. The pieces of wood, of about 14in. in length, are placed in these chambers, and are pressed against the stone, by means of a screw at the end of the piston rod passing through a fixed nut; this rod is slowly turned by means of suitable gearing connected with the machinery. The nut is made in two halves, held together by clips, which are slackened out when it is required to withdraw the pistons. The wood in this manner is reduced into a pretty homogeneous mass of fibres, and, mixed with water, passes to the coarse sorting apparatus V S.

This consists of a cylinder covered with coarse wirework, revolving in a tank; the fibres pass to the centre of this cylinder, and the coarser splinters which constitute the waste, (but in a very small proportion), are stopped by the wirework, and float to the surface of the water, and are removed to a box at the side by means of a revolving rake.

It next passes to the refiner R, where it is ground between a pair of millstones; the fibres are in this manner made more pliable and clean.

From this it passes to the sorting apparatus S, when the wood fibres are sorted according to their degree of fineness.

Those consist of two drums covered with wire gauze, the first finer than the second, revolving in separate bands, the finer fibre passes through the first drum to the second tank, the pulp remaining in the first tank constitutes pulp No. 3, which is used for the common sorts of paper; in the second tank the finer pulp, No. 1, passes through the wire gauze of the revolving drum, and that remaining in the tank is used as pulp No. 2. The pulp, No. 1, is conducted to a third tank in which is a revolving drum covered with wire gauze with 40,000 holes to the square inch, which effectually drains the water away. The water is further pressed out, if required for the purpose of transport, from the pulp by means of a roller from Z P. This machine consists of an endless cloth upon which the pulp is fed, and passes between a series of rollers.

In large establishments the pulp is sent away to great distances in the shape of card board, which is made by a very simple machine and dried in summer in the open air, and in winter in a warm room. The pulp looses nothing of its quality and is easily dividable, and can even by the means of slightly heated cylinders be made into a kind of loose paper.

The production of this machine is from 12cwt. to 15cwt., calculated dry, per day of twenty-four hours, and requires only ten to twelve men; six of them are employed for cutting the wood, and the others for attendance of machine by day and night.

Upwards of ninety of these machines have been constructed and are at work:—In Canada, 1; Austria, 11; Baden, 1; Bavaria, 5; Belgium, 10; Denmark, 1; England, 1; France, 8; Prussia, 17; Russia, 3; Saxony, 14; Norway and Sweden, 6; Switzerland, 5; and Wurtemberg, 7.

REPORT ON RAILWAY APPARATUS, CLASS 63, IN THE PARIS EXHIBITION.

By Sir D. Campbell, Bart.

The objects exhibited in this class consist principally of locomotives, designs and models of locomotives, railway carriages, goods-waggons, signals, turn-tables, specimens of permanent way, weigh-bridges, models of various systems of brakes and of modes of communication between passengers and guards, specimens of wheels and axles, and other ironwork employed in the manufacture of railway rolling-stock. Eighteen different countries figure in the official French catalogue as contributing to the Exhibition in this class; but Spain, Portugal, and Norway having failed to send the objects in their respective lists, this number is reduced to fifteen. The following table shows the actual number of exhibitors from each country:—France, 90; Holland, 5; Belgium, 24; Prussia, 20; Grand Duchy of Baden, 1; Wurtemberg, 2; Bavaria, 2: Austria, 22; Switzerland, 2; Sweden, 3; Russia, 2; United States, 7; Great Britain, 24; Canada, 5; total, 214.

In several instances, and more particularly in the case of the great French railway companies, which contribute largely to the French department, a considerable number of objects are sent by one exhibitor; and thus the number of "exhibits" is about 50 per cent in excess of that of the exhibitors.

The most prominent feature in this section of the Exhibition is the great advance made by the Continental workmen in the quality of their workmanship, which is in many instances quite equal to that of the best English workshops. In point of novelty of design there is not very much to be noticed since the Exhibition of 1862.

The locomotives exhibited are thirty-two in number. Of these France contributes eleven passenger and goods engines, and two small tank-engines for tramways. Belgium sends five, Prussia two, Baden one, Wurtemberg one, Bavaria one, Austria three, the United States one, and Great Britain three passenger-engines and two contractors' tank-engines. In addition to these, Mr. Fell's engine for the Mont Cenis Railway will probably be in its place before the close of the Exhibition. The completion of it has hitherto been delayed by difficulties experienced in controlling the action of the horizontal wheels, working on the central rail, which, it is hoped, have now been overcome.

These constitute, undoubtedly, the most important class of objects exhibited under this head, and in reviewing them it is important to bear in mind the different conditions of the countries, lines of railway, and traffic for which they are intended.

England has a network of canals, and the sea, with its fleets of coasting vessels, to supplement her railways in the conveyance of coal and other heavy traffic. On the Continent, these aids either do not exist, or do so, generally, in a very much modified form, so that the heavy traffic is thrown almost entirely on the railways, and such is the accumulation of this species of traffic upon some of the French railways at this moment, that, unless the capacity of the trains be increased, there would seem to be no alternative but, at a not very far distant date, to lay down separate lines of rails for the goods traffic, as has already been done to a limited extent on the London and North-Western Railway.

From this circumstance arises the demand for large engines capable of drawing the heaviest possible loads, the limit of which is only fixed by the strength of the waggon couplings or of the waggon frames themselves. On the other hand is to be taken into consideration the increased first cost of these engines, the loss of tractive power whenever they are laid up for the most trifling repair, the greater wear and tear of permanent way occasioned by them, and the increased strength of construction required for the bridges, &c., the weight of the heaviest engine in use being taken as the unit of measurement. And it may be here observed that the ten-wheeled tank-engine of the Paris and Orleans Railway has a weight of sixty tons on a wheel base of only 14ft. 10½in. On the whole, the balance of opinion in England, in an economical point of view, is against the use of these monster engines, whose enormous bulk and weight have also found little favour with English observers. A noticeable feature in connection with these large engines is the extensive use of steel for the boilers, piston-rods, connecting and coupling rods, in order to keep down the weight without losing strength.

In contrasting the continental with the English engines it will be observed that, whereas the latter have only six wheels, the former have frequently eight, and sometimes ten, and even twelve wheels, which are rendered necessary by their greater weight. In England the inside cylinder is largely adopted; and, whether with that or the outside cylinder, the machinery is simplified as far as possible, and concentrated under the boiler and within the wheels, bringing the line of force as near as may be to the line of traction. In the continental engines the cylinders are generally outside, and the valve gear carried at the extremity of overhanging crank-arms outside the connecting-rods of the coupled wheels, and frequently projecting nearly 2ft. beyond the rails. This system has been adopted partly with the idea of giving greater facility of access to the machinery, and partly from the dread of cranked axles. A symptom of this may be observed in a new engine by Cail and Co., where the crank-arms are strengthened by wrought-iron hoops, shrunk on—a precaution sometimes adopted in England with old engines, but seldom thought necessary for new ones. In the tank-engines exhibited the tanks of the continental engines are generally placed parallel to the sides of the boiler, and overhang; whereas the saddle-tank, on the top of the boiler, is generally adopted in English engines. This overhanging weight and valve gear must tend to produce more unsteadiness in the engines, and, in the latter case, would seem to give more facility for wear, and consequently for loss of lead, than those built on the English plan.

In point of workmanship, however, many of the Continental engines are fully equal to those made in English workshops; and it is especially to be remarked that M. Schneider and Co., of the Creuzot Ironworks, exhibit a remarkably well-finished express-engine, made from English drawings, for the Great Eastern Railway. It is the sixteenth completed out of an order for forty; the first fifteen having been already delivered over to the railway company and accepted by them, the period of warranty for them having expired.

Mr. Kessler, of Esslingen, exhibits a locomotive built by him, from English drawings, for one of our colonies, it being part of an order from the East India Railway Company for twenty engines. The workmanship of this is equally good. These two engines afford incontrovertible proof of the possibility of getting English designs carried out abroad quite as well as at home, and at a cheaper rate.

With regard to the display of railway carriages, of which England has failed to send any examples, the general character is very good. The prominent features consist in the universal adoption of the overhung body, by which an additional place is obtained on each seat, which system is also adopted on some railways in England; the substitution of iron for wood in the frames; the comfortable fittings of the second and also of the third class carriages, as compared with those in England; the generally defective lighting, and in some cases the total absence of ventilation, more especially in the carriages of the Chemin de Fer de l'Est in France, and in those exhibited in the Prussian section, one of which, moreover, is a smoking carriage. For comfortable fittings, good ventilation and lighting, and general excellence, a carriage in the Belgian section, made by the Compagnie Belge, may be especially noticed. The two-storied carriages exhibited by the Chemin de Fer de l'Est and by M. Vidard are also deserving of notice. They are intended chiefly for suburban traffic, and, doubtless, in point of economy, if not comfort, they may be considered successful.

The signals exhibited, and especially those in the Prussian section are not so solidly constructed as those in general use in England; and there is nothing in point of concentration and arrangement of signals and points, with the requisite locking apparatus for the prevention of accidents, to be compared to the model exhibited in the English section by Messrs. Saxby and Farmer. In the French section M. Vignier exhibits a simple system of

locking-signals and points, which he introduced in France many years since; but he does not demonstrate the applicability of his plan to a large and complicated system, such as exists at the Charing-cross and Cannon-street stations in London, in and out of which latter station no less than 712 trains with engines passed on Easter Monday last; and in the signal-box there, as many as sixty-seven levers for points and signals, with the necessary means of locking, are comprised in one apparatus. In France, however, concentration of signals is often avoided on purpose, and the signal-levers are separated by a space of thirty yards, in order to prevent a signalman from giving contradictory signals simultaneously, or, at all events, to ensure his detection in the event of his having done so.

In the Belgian and Austrian sections specimens of wheels, axles, rails, boiler-plates, and other wrought-iron work, occupy a prominent position. The latter, especially, exhibits some very fine samples of forgings, &c., in Styrian iron, the quality of which cannot be easily excelled. France also exhibits some excellent castings of cylinders, axle-boxes, &c. In the English section this description of work is exhibited in Class 40, where the specimens from the Lowmoor, Barrow, Clarence, Atlas, and Earl Dudley's ironworks are to be found.

A variety of different systems of iron permanent way are exhibited, the majority having iron transverse sleepers of different sections; some, as in the case of the Economic Permanent-way Company, adopting a series of large cast-iron chairs, supporting each rail independently, as used to be the case with the stone blocks, now abandoned in England, but having tie-rods to keep them in gauge. The principal objections to them, generally, appear to be the slightness of the sleepers (in order to keep down the cost) and the small hold they have of the ballast, especially in hot countries, for which they are particularly required, where the upper surface of the ballast is more exposed to pulverisation than in more temperate regions.

It should be noticed that the "Vignoles," or flat-bottomed rail, is becoming very largely adopted on the Continent, dispensing with cast-iron chairs altogether. At the joints, these rails, besides being fished in the usual manner, have a wrought-iron plate on a sleeper under them, and they are secured to the intermediate sleepers simply by bolts having a head formed so as to catch the rail.

Many ingenious modes of communication between passengers and guards are exhibited, consisting of acoustic, pneumatic, and electric signals; the latter forming the great majority, and being largely experimented upon in France, where, however, it is found that, owing to various disturbing causes in reference to the electric connection between the carriages, about 33 per cent. of the signals attempted to be given do not take effect. In many cases the signal-handles in the carriages are protected by glass covers, which the traveller is invited, in case of need, to break with his elbow, in order to reach the handle within. This arrangement, involving the necessity of placing the handle either at the side or in the partition of the carriage, must render the signal practically useless in the event of an assault by a powerful antagonist. It has, however, the effect of deterring nervous or weakminded as well as mischievous travellers from giving the signal on frivolous pretexts, while it would answer very well in any of the ordinary cases for which it is desirable to afford the facility of communication with the guard; and it only remains to perfect the means of maintaining the electric current in its integrity to be able to satisfy the legitimate requirements of the travelling public.

On proceeding to describe in detail the objects exhibited by the various countries, taking them in the order in which they are placed in the French official catalogue, and the position they occupy in the building, the first country on the list is France, which, as might have been expected, in completeness and in numbers, as well as in the completeness of its contribution, stands pre-eminent. The leading French railways, more especially the Eastern of France and the Paris, Lyons, and Mediterranean Railways, have shown a most commendable amount of public spirit in the scale they have adopted for their contribution to the display made by their country.

The objects exhibited by France are to be found in three different localities—viz., in the outer gallery appropriated to machinery within the building, in a covered annexe with open space adjoining in the park, and in the shed devoted to the production of the Creuzot Ironworks.

Within the building may be observed No. 68 in the catalogue, which is a locomotive engine, belonging to the Paris, Lyons, and Mediterranean Railway Company. It is intended for express passenger traffic, on gradients of 1 in 120, for which purpose it has been altered from its original form, by having the boiler lengthened, the driving wheels increased in diameter, and the trailing wheels placed behind the ashpan. It is an excellent, substantial, and well-finished piece of workmanship; it has six wheels, of which the four leading ones are coupled; it has inside cylinders, and inside bearings for the coupled wheels, and outside bearings for the trailing wheels. It is provided with screw reversing gear and a species of steam brake, the apparatus for which as well as for the reversing gear, and a specimen of the pistons and of the hollow copper stays for the fire-box used by this company, are separately exhibited on a stand in front of the engine.

This system of steam brake, or "contre vapeur," is that employed on the North of Spain Railway. It is highly approved of by the French engineers, and has been adopted by them to a considerable extent; and there are several other locomotives exhibited, either with the same apparatus or slight modifications of it. It consists in introducing a mingled jet of steam and water into the cylinders, the engine being reversed. The water, mixed with the steam, keeps down the temperature and relieves the piston, and is driven back into the boiler without increasing the pressure in it or damaging the cylinders, &c., by the inspiration of impure air, loaded with ashes and grit, from the blast pipe, as is done by reversing under steam in the ordinary way; while, owing to the small quantity of steam admitted, the shock to the machinery is very slight, and can be reduced to a minimum.

The apparatus consists of two pipes of small diameter, for water and steam respectively, which are admitted into them from the boiler by means of two small slide-valves fixed beside the reversing gear. These valves are worked by screws with crank handles and regulating indexes attached so that the engine driver can admit water and steam, in the quantity and proportion he desires, into the pipes, which are united into one at a short distance from the foot plate, and then led along the outside of the boiler and below the smoke box, whence they branch off again to the cylinders on each side.

The principal dimensions of this locomotive, as furnished by the constructors, are—area of fire-grate, 13½ sq. ft.; number of tubes, 158 length of tubes, 13ft. 1½in.; interior diameter of tubes, 1⅞in.; total heating surface, 1,060 sq. ft.; mean diameter of the boiler, 4ft. ⅝in.; diameter of the cylinders, 1ft. 4¼in.; stroke, 1ft. 10in.; wheel base, 15ft. 1½in.; diameter of coupled wheels, 5ft. 10⅝in.; diameter of trailing wheels, 3ft. 7¼in.; weight when loaded, 28¼ tons.

Next in position is No. 71, a six-wheeled engine, all coupled, with a six-wheeled tender engine, also having all the wheels coupled, and built at Graffenstaden, for the Eastern of France Railway, on Surrock's system. This railway has a very steep and undulating section, especially on the portion between Forbach and Niederbronn, where the ruling gradient for about forty miles is 1 in 66, with a constant series of ascents and descents. The heavy traffic on this line is principally from the coal basin at one of its extremities, and consequently the greater part of it goes in one direction. If this traffic were worked by a single engine, the load would be limited by the steepest gradient, and for fully one-half the distance where the gradients are flat or descending the engine would not utilise its whole power; similarly, if a second engine were used as an auxiliary on the steep portions, its power would be wasted on the flat or descending gradients, and it would have a large mileage to run back without a load. In order to meet this economical difficulty, the railway company have adopted this system of engine, with its large boiler and fire-box, capable of supplying steam to the tender engine at the points where its use is required, and where only it is employed as a motive power. The tender weighs when loaded 28 tons, the adhesion of which is thus utilised. It must be observed, however, that this type of engine has been largely employed on the Great Northern Railway in England, where its use is now being abandoned. The principal dimensions of the engine are as follow—area of fire-grate, 26 sq. ft.; number of tubes, 276; length of tubes, 9ft. 10in.; diameter of tubes, 1⅝in.; diameter of boiler, 4ft. 11in.; total heating surface, 1,422 sq. ft.; diameter of cylinder, 16½in.; stroke, 23⅝in.; wheel base, 11ft. 7⅝in.; diameter of wheels, 4ft. 3¼in.; weight, loaded, 34½ tons; weight of tender, loaded, 28 tons. It is provided with screw reversing gear, and the same system of steam brake as that described above on the Paris, Lyons, and Mediterranean Railway locomotive. In order to keep down the weight, the boiler, fire-box cover, axles, and connecting rods are made of steel. It has inside cylinders, and the waste steam from the tender engine escapes directly into the atmosphere.

No 70 is a powerful goods engine, with six coupled wheels, belonging to the Southern of France Railway Company, and having the peculiarity of being capable of transformation into a passenger engine by the substitution of 5ft. 3in. wheels for its ordinary wheels of 4ft. 3¼in. diameter. The connecting rods work one on a horizontal and the other on a vertical joint, in order to admit of the play in the wheels on going round sharp curves. The springs of the four leading wheels are above the axles; those of the trailing wheels below the axle.

The next in order is No. 63, which is a large and very powerful goods engine, built by Messrs. Cail and Co. and the Compagnie de Fives-Lille for the Northern of France Railway. It has eight coupled wheels, with brake blocks on both sides of the trailing wheels. The leading and trailing wheels have from ⅜in. to ⅝in. lateral play. It has a long fire-box, on the Belpaire system, for burning small coal. The cylinders are outside. The workmanship of this engine is excellent, but the valve gear is very overhanging, and therefore displeasing to an English eye. The principal dimensions are—area of fire grate, 23½ft.; number of tubes, 249; length of tubes, 13ft. 5½in.; diameter of tubes, 1ft. ⅝in.; total heating surface, 1,757 sq. ft.; mean diameter of boiler, 4ft. 11in.; diameter of cylinders,

19ft. ¾in.; stroke, 25½in.; wheel base, 13ft. 11⅝in.; diameter of wheels, 4ft. 3¼in; weight, loaded, 42½ tons. There is also shown by the same exhibitors a pair of wheels, with Caillet's plan for admitting lateral play and restoring the wheels to their normal position on entering and leaving sharp curves. It consists of an iron bar placed above the axle, and having at each end a horizontal spring, which yield to the pressure on the flanges of the wheels in the curves, but are of sufficient power to restore the wheels to position on that pressure ceasing. They also exhibit a drawing and model of a draw bar attached to shifting levers, which work laterally on entering a curve, and keep the line of traction in the direction of the middle of the engine, between the two central pairs of wheels. Also a drawing of a compressed air brake, by M. De Bergue, which consists of a receiver placed on the top of the boiler of the engine, into which, by a simple apparatus, the piston, on the steam being cut off, is made to condense air, drawn from the exterior, and not through the smoke box. This receiver has a safety valve that can be adjusted to the desired pressure, which is the measure of the resistance offered to the course of the piston, and which is gradually increased at each stroke of the piston until the maximum is reached, so that all shock to the machinery is avoided.

No. 65 is a locomotive for mixed traffic, built for the Grand Duchy of Baden railways, at the Graffenstaden works, where the engine above described, belonging to the Eastern of France Railway, was also constructed. It has four coupled wheels, 5ft. 6in. in diameter, outside cylinders, and weighs 26 tons, giving the large weight of 13 tons on each pair of wheels. The cranks of the axles are on Hall's plan, being let on to the ends of the axles and forming part of the bearing. The axles and tires are made of Krupp's steel and the boiler of cast steel. The wheel base is only 8ft. 6⅝in., which permits of going round very sharp curves. The workmanship is good.

No. 62 is an express engine, belonging to the Paris and Orleans Railway Company, which has been employed since its construction, in December, 1861, on the sections from Périgueux to Agen and to Capdenac, the steepest gradient being 1 in 63, and has run a distance of 90,532 miles at a total cost for maintenance of £106 6s. 6d., or about a farthing per mile. The leading wheels have been replaced, but the driving-wheels have neither been changed nor turned up. It has six wheels, of which the four hinder ones are coupled, and has outside cylinders and outside overhanging valve gear. It has steel boiler, tires, connecting and piston rods; and is fitted with Arbel's stamped wrought-iron wheels. The firebox has Tenbrincks, smoke-burning apparatus. It has screw reversing gear; and can take a load of 126 tons up a gradient of 1 in 100, or of ninety tons up 1 in 63.

No. 58 is a specimen of the locomotives used on the tramways of the Commentry Ironworks, and is exhibited, not as displaying any novelty, but as a type of engine which the experience of several years has demonstrated to be exceedingly well adapted for traffic of this nature. It can take forty empty waggons, each weighing 28cwt., up a gradient of 1 in 33 at the rate of sixteen miles an hour; and forty waggons of coke up 1 in 220 at the rate of six miles per hour. The curves on these tramways are in some places of only five chains radius, and this engine has gone round a curve of only two chains radius The cylinders are placed high, and at an angle, on account of the narrowness of the cuttings and platforms. The company have eleven of these engines; and the annual traffic worked by them amounts to 400,000 tons of coal and coke in one direction, and a return traffic in the other direction of from 20,000 to 25,000 tons.

No. 35 is a tank-engine, intended for the goods traffic on the Aurillac and Murat section of the Paris and Orleans Railway, on which there are gradients of 1 to 33, and curves of 15 chains radius. It has ten wheels, all coupled and divided into groups of two pairs each, on each side of the central or driving wheels. The load on each group of wheels is evenly distributed by means of compensating levers. The central wheels are fixed. The first pair on each side of them have a lateral play of 5-16in., and the leading and trailing wheels have each 11-16in. of lateral play, which is regulated by means of inclined planes on the grease-boxes. The framing is inside for the three leading pairs of wheels, and outside for the two hinder pairs, and is so constructed in order to give the greatest width possible for the fire box. The cylinders are outside, with overhanging valve gear. The coupling rods of the leading and trailing wheels have universal joints, to allow for the lateral play, and also for the twist occasioned by the difference in level of the outer and inner rails in sharp curves. There are two fire doors, to facilitate the distribution of the fuel in the fire box, and the steam brake of the North of Spain Railway is adapted, with a slight modification. The sand box is placed near the base of the chimney, which keeps the sand always dry. This engine takes a load of 150 tons up a gradient of 1 in 33. The principal dimensions are as follow:—Area of fire grate, 22¼ sq. ft.: number of tubes, 280; interior diameter of tubes, 2in.; length of tubes, 16ft. 4⅞in.; total heating surface, 2,257 sq. ft.; mean diameter of the barrel of the boiler, 5ft. 3in.; diameter of cylinder, 19⅝in.; stroke, 23⅝in.; wheel base, 14ft. 10½in.; diameter of wheels, 3ft. 6½in.: weight, loaded, 59 tons 12 cwt.; empty, 46 tons 15 cwt. The boiler, tires, and piston rods are of cast steel; the frames, axles, and springs of Bessemer steel; and the wheels are stamped by Arbel's process.

Next to this is No. 37, a six-wheeled engine, by Cail and Co., for the Northern of France Railway. In general appearance it is similar to that already described belonging to the Paris, Lyons, and Mediterranean Railway, having the four leading wheels coupled, inside cylinders and bearings for the two leading pairs of wheels and outside bearings for the trailing-wheels. It has brake blocks in front of leading and trailing wheels, and the crank-arms of the axle of the driving wheels are strengthened by wrought-iron hoops shrunk on.

Next to this is the only remaining engine in the French section within the building. It is a monster goods engine, made by Gouin; for the Northern of France Railway, on Petiet's system, and appropriately named "Le Titan." It has four outside cylinders and twelve coupled wheels, and a second boiler and large steam chest superimposed. The tubes are passed through the latter, superheating and drying the steam. The chimney is horizontal, and projects beyond the foot plate. A somewhat similar specimen was exhibited in London in 1862. The weight, when loaded, is 58½ tons; when empty, 45½ tons; wheel base 19ft. 8¼in.

In the shed appropriated to the "exhibit" of the Creuzot Ironworks are three locomotives—one being a beautifully-finished little tank engine, for mines or tramways. It is constructed for a gauge of 2ft. 7½in., has four coupled wheels, outside cylinders, and overhanging valve gear, can go round curves of sixteen yards' radius, and up gradients of 1 in 16, and altogether is a very handy little engine. Diameter of cylinders, 8ft.; stroke 14⅛in.; wheel base, 4ft. 9in.; diameter of wheels, 2ft. 6in.; weight when loaded, 6½ tons; empty, 5 tons 4cwt.

The second is a tank engine with six coupled wheels, outside cylinders, and overhanging valve gear, and is a specimen of those used in the Creuzot works themselves, which are of enormous extent, and give employment to 10,000 workmen. The tank is placed parallel to the boiler and below the top of it, and overhangs considerably. The buffers are provided with double horizontal elliptic springs. The workmanship is very good. The third is an express six-wheeled engine, built from English drawings for the Great Eastern Railway. The workmanship of this engine is also exceedingly good. The driving wheel is 7ft. 1¼in. in diameter; leading and trailing wheels, 3ft. 7½in.; wheel base, 15ft.; diameter of cylinders, 16ft.; stroke, 24ft.; weight when loaded, 32 tons; empty, 29 tons; area of fire-grate, 15½ square ft.; number of tubes, 190; length of tubes, 12ft.; diameter of tubes, 1⅝in.; heating surface, 1,123 square ft.; diameter of boiler, 3ft. 11¼in. The fire bars are rounded at the ends, and oscillate so as to free themselves from the ashes; and the firegrate is convex in form, so as to convey the fuel to the angles of the firebox. The cylinders are outside, and the eccentrics inside. The trailing wheels have outside bearings, the remainder having inside bearings. The tires are made of Krupp steel, fastened on by Beatty's patent clips. There is a cross spring for the leading wheels; and the driving-wheel springs are below the axle, and are combined with springs made of alternate plates of iron and india-rubber.

Within the main building the Northern of France Railway Company exhibit a model of the very ingenious disposition of the different lines belonging to their system near the entrance to their Paris terminus. From the requirements of the traffic arrangements, it was found necessary that the arrival and departure platform for the main-line trains should occupy the extreme right and left of the Paris station, and that those for the Pontoise and Soissons trains should be placed in the intermediate space. At the third kilometre from Paris it was necessary that the Pontoise Railway should cross over to the left, and the Soissons line to the right, of the Chantilly or main line. The goods station at Paris is situated on the right-hand side of the whole system of lines, so that a down goods train to Pontoise must cross the whole of the up and down lines intervening, in order to reach the extreme left or down line to Pontoise. To admit of this, and also of the crossings of the main line by the branches to Pontoise and Soissons without interruption to the traffic in any direction, the disposition of the lines, with the over and under bridges, as shown in the model, was devised. The original gradient was a fall of 1 in 250 from Paris, which remains unaltered as regards the up lines; while, for the down lines, the steepest rising gradient introduced is 1 in 250, and the steepest falling gradient 1 in 83. As originally constructed all these lines were on the same level, but the delay and danger occasioned by the different crossings were so great that the above plan was invented and carried out without interrupting the traffic. The various down lines are shown in the model by copper rails, and the up lines by brass rails, so that the course of each train can easily be traced on it to the proper destination, and the efficacy of the system satisfactorily demonstrated.

No. 75 is a working model of a pneumatic railway, designed by M. Bergeron, for the conveyance of passengers from the harbour of Lausanne to the railway station, which is situated at a considerable height above the port, necessitating a steep incline on the short branch line which is to connect these places. It is proposed to construct an iron tube or tunnel, with a sliding door at the lower end. Near this point is to be placed a

large receivor, similar to an ordinary gasholder, and connected by a pipe with the interior of the tube immodiatoly within the door. The carriage, by means of a ring of packing which surrounds it, is made to close the tube almost hermetically. The mode of working is as follows:—To ascend the incline—The receiver is raised to its greatest height by means of a hydraulic press worked by a small steam-engine; the carriage is then introduced into the tube, aud the sliding door is shut. The water in the hydraulic press is lot off, the receiver descends by its own weight, compressing the air behind tho carriago, which, being vory much lighter than the receiver, is driven forward to its destination. To doscend, the process is reversed. The door of the tube at tho lower end is shut as before, and the carriage is introduced into the tube at the upper ond. The receiver is then raised, and partially exhausts tho air within the tube. The pressure of the external atmosphore drives tho carriage forward at each stroke of the hydraulic press until the bottom of the incline is reached, whilo the air still remaining in the tube acts as an atmospheric brake, and prevonts the carriage from dashing against the door. It is vory questionablo, howover, whether a stationary engine, with the ordinary wiro rope, would not be a better and a cheaper mode of locomotion. The special recommendation put forward for this plan is, that a very much smallor stoam-engine is required to work the hydraulic press than would be required for an incline with a rope.

No. 57 is a model of a safety brake for steep inclines, and is adopted on the short branch of railway from Lyons to La Croix Rousse. It consists of a pair of friction wheels suspended on each side of the break van, over the rails, but clear of them. To each friction wheel is attached a pair of clips, which embrace the sides of the rails. The brake is self-acting, in the event of the coupling giving way, when a catch is liberated, allowing the friction wheels to fall on the rails. These wheels, in revolving work a screw connecting each pair of clips, and close them tightly on to the rail, stopping the train in a very few yards. The brake can also be put on by hand from the interior of the guard's van. The rails used are of the Vignoles type, made high in the web.

No. 59 is a specimen of the stationary pumping engines used on the Paris, Lyons, and Mediterranean Railway for supplying the water tanks at the stations. It is a plain, strong piece of work, and well adapted for its purpose. The air vessel is somewhat large, but is made so in order to be fit for the greatest height to which it may be required to pump the water.

No. 45 is a goods van, exhibited by the Eastern of France Railway Company. It is provided with a "Stilmant brake," which consists of a pair of levers, disposed in the form of a horseshoe and jointed in the centre. Within these is placed a wedge, moved vertically by means of bell-crank levers from the interior of the van in the usual way. The brake blocks are attached to rods fixed to the lower ends of the arms of the horseshoe levers. On putting on the brake, the wedge is made to descend, expanding the arms of the horseshoe and forcing the blocks against the wheels. This system of brake is extensively used in France.

No. 40 is a guard's van, exhibited by the Eastern of France Railway Company, and is fitted with Achard's electric brake, for which system the Montyon prize of 2,500f. was awarded in 1865. This brake is a combination of mechanical means with electricity, and consists of a lever, fixed with a vertical joint to the under side of the frame; a spring is placed above this lever, which forces the other extremity on to an eccentric cam on the axle of one pair of the van wheels. This cam, in revolving, gives the lever an up-and-down motion; and, by means of a shortarm working from the end of the lever into a ratchet wheel, each revolution moves on the ratchet wheel, one cog. An electro-magnet is fixed to the frame near the extremity of the lever, and then connected with the electric current is sufficiently powerful to counterbalance the weight of the lever increased by the pressure of the spring, and holds it clear of the eccentric cam, which then revolves without touching it. The ratchet wheel is fixed to one extremity of a shaft, to the centre of which is fixed a powerful circular electro magnet, having on each side of it an iron collar, with a broad, soft iron disc on the side next the electro-magnet. These collars revolve freely round the shaft; but, when the electro magnet is connected with the electro current, the soft iron disc adheres firmly to it, and the collars are made to revolve with the shaft. To these collars are fastened chains, which pass over a pulley secured to the frame, are then led round a sheave at the extremity of the lever which works the brake block, and are finally fastened to a hook in the frame. The electro magnet on the ratchet wheel shaft is made of such power, that the force of adhesion to it of the collar discs is greater than that required to lock the wheels of the van. On interrupting the main electric current, which is effected by means of commutators placed on the engine and in the guards' vans, and also by any part of the train becoming detached, the magnet suspending the lever ceases to act, the lever falls on the eccentric cam, and at each revolution of the wheels the ratchet wheel is moved ronnd one cog, carrying with it the circular magnet to which the collars adhere, and winding up the chains which are attached to the latter. These chains, on being tightened, press the brake blocks on the wheels; and in order to prevent their being locked a dynamometer is attached to the hook, by which the chains are fastened to the frame, and is adjusted so as to yield before arriving at the pressure required to lock the wheels, and in so doing it moves a commutator, which cuts off the electric current from the circular magnet on the shaft. The collars are then liberated and the chains become unwound, and the pressure is taken off the brake blocks, on which the dynamometer resumes its first position, the current is restored, and the brakes are put on again and again until the train is stopped. There are other modifications for maintaining a given pressure, short of locking the wheels.

No. 61 is a weigh-bridge for railway carriages, capable of weighing 30 tons. It is made by M. Sagnier and Co., and has a simple apparatus for locking, which consists of a shaft at each end, supported on strong pedestals, and made to revolve simultaneously by pulling over a lever placed near the steelyard. On both ends of these shafts are eccentric cams, which when the shafts are turned round come under the longitudinal bearers of the weigh-bridge and take the weight off the weighing machinery, so that it may be run over by engines without injury.

Mr. Sagnier also exhibits a good weighing-machine for adjusting the springs of locomotives. It has ten separate bridges, with the steelyards brought close together. By this means the ten wheels of an engine may be simultaneously weighed and the springs adjusted.

(To be continued.)

DISTILLING APPARATUS AT THE PARIS EXHIBITION.

Exhibited by Messrs. Vangindertaelen and Co., Brussels.

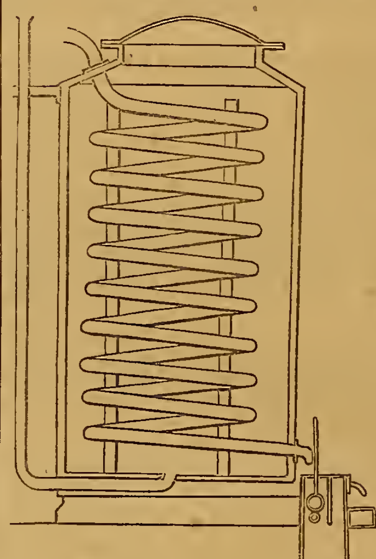
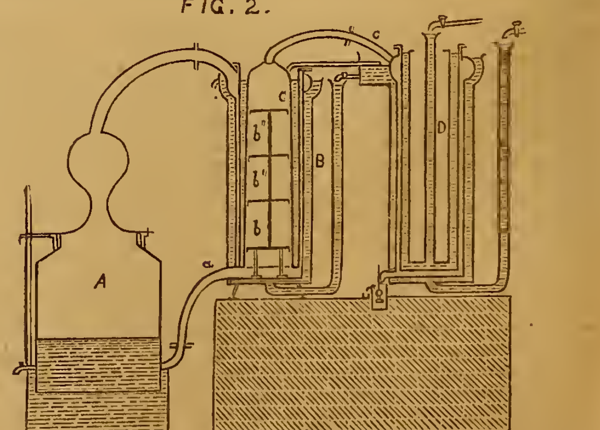


FIG. 1.

In 1862 Messrs. Vangindertaelen and Co., of Brussels, commenced and exhibited a new distilling apparatus, of which the following were the chief features.

The ordinary worm Fig. 1, as generally used in distilleries is liable to many inconveniences. As the copper tube it consists of cannot be cleared by hand, and for this reason, as well as on account of its being not tinned, the manner in which the distillation used to be performed is a most insalubrious one; also, the way the vapours travel being a very long one, the operation generally goes on too slowly. To do away with all these objections which have been urged against the existing apparatus, Messrs. Vangindertaelen and Co. have executed the apparatus shown (Fig. 2), facsimiles of which are stated to be at work now in several distilleries of France and Belgium.

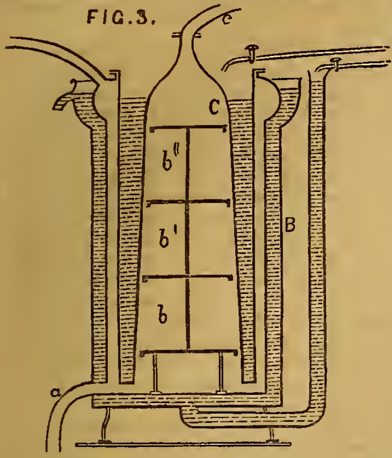
FIG. 2.



From the still A, the vapours pass through the tube *a* into the rectificator B. In this rectificator (shown on a larger scale in Fig. 3) which consists of a cylindrical vessel, like the common ones, the worm is super-

seded by a series of chambers, *b*, *b′*, b_2, surrounded by another cylindrical vessel C. In these chambers the vapours which are less volatile, are condensed and pass back to the still A, through the pipe *a*, whereas those which are not condensed ascend to the cooler D, by the pipe *c*. The construction of this cooler also varies from the common ones; in this, as well as in the rectificator, the worm is entirely suppressed, and a set of cylindrical vessels, the one inside the other, substituted for it.

FIG. 3.



The remaining parts of the distilling operation are performed in a manner similar to the common means of distilling, with the difference only which arises from the different construction of the apparatus. The great superiority of this contrivance over the worm which is generally used is striking enough, but as we have not had an opportunity of seeing Messrs. Vangindertaelen's apparatus at work, we can adduce for the present no other evidence than the favourable opinion of the Académie Royale de Médecine de Belgique was recorded, and the medal of the Jury of the International Exhibition was awarded to the inventor.

In the Paris Exhibition the inventor has again come forward with apparatus of the same general character, but with modifications and improvements in the details.

AGRICULTURAL ENGINE TRIALS AT THE ROYAL AGRICULTURAL SOCIETY'S ANNUAL SHOW AT BURY ST. EDMUND'S.

According to the conditions laid down by the Royal Agricultural Society, the engines to be tested were divided into three classes—namely, fixed engines, portable engines with two cylinders, and portable engines with one cylinder. The trials of these three classes were carried on simultaneously; but it will be convenient that we should consider them here in the order abovenamed. It was intended that the trials should have begun on Wednesday, the 10th of July, and finished by Saturday, the 13th; but the arrangements were not finished in time, and consequently no fair commencement could be made until the morning of the 12th, and the proceedings being further delayed by bad weather, the concluding trial of the second series was not made until the evening of Tuesday, the 16th. The results of the trials were as follows:—

FIXED ENGINES.

According to the published list, twenty fixed engines were originally entered for trial, but of these only six were ultimately tested. The engines were supplied with steam from the boiler belonging to the society, and being fired by the representative of each maker in turn as his engine came under trial. By the society's rules, the diameter of the cylinder of each fixed engine tested was not allowed to exceed 11½in., and the power was estimated at the rate of one horse power for each 10 circular inches of piston area, the power thus obtained being that upon which the allowance of fuel was based. This allowance consisted of 14lb. of coal and 1lb. of wood per horse power, an engine with a 9in. cylinder thus having allotted to it 8·1lb. of wood and 81lb. of coal. The maximum pressure of steam permitted was 50lb. per square inch. In commencing each trial, the connexions having been made between the engine to be tried and the boiler, steam was got up in the latter until the allowed pressure was attained. At the same time the engine was connected to the friction-brake, and the latter loaded so that, when the engine was run at its nominal speed, it would develop a dynametrical power equal to the power at which it was estimated by the society's rule. When steam had been got up to the required pressure, the fire was cleared out of the boiler, and a fresh fire kindled with the fuel which had been weighed out for the trial; and the engine was then started, and run as long as sufficient steam could be maintained to work it at its nominal speed. The level of the water in the boiler was noted at the commencement of each trial, and it was required to be at the same level at its termination. The time run by each engine was calculated not by the actual time which elapsed between the beginning and end of each trial, but by the number of revolutions recorded by the counter attached to the brake; this number, divided by the nominal number of revolutions of the brake per minute, giving the number of minutes of what was termed, for convenience, "mechanical time." During the trials of the fixed engines, the boiler was in all cases fed with cold water, and it is to this that the diminished duty performed by the fixed engines as compared with the portable engines per pound of coal is to some extent due. The loss of heat from radiation from the surfaces of the steam-pipes, &c., was also greater in the case of the fixed than in the portable engines, although some of the makers, and Messrs. Clayton, Shuttleworth, and Co. especially, took every care to guard against this as far as possible, by covering the connecting steam-pipe and cylinders with felt laid over them. The powers of the fixed engines tried, together with the results of the trial, are given in the annexed table, No. V., in which the engines are arranged in the order of the duty performed by them.

The fixed engine submitted for trial by Messrs. Clayton, Shuttleworth, and Co. was, like the other engines sent by that firm, excellently proportioned, and a beautiful specimen of workmanship. It is a horizontal engine, with the cylinder and covers steam-jacketted. The cylinder has short steam-ports, there being an exhaust-port for each end; and the slide-valve is fitted with an expansion-valve working on the back, the main slide and the expansion-valve being each driven by an eccentric. It had been intended by the makers to run the engine at a speed more greatly in excess of the nominal speed than that at which it was actually worked during the trial, but an objection having been made to this, the eccentrics were altered at the last moment, and the engine run without any preliminary trial to test the adjustment of the valves having been made. The speed of the engine having been thus altered necessitated its being worked with the governor disconnected. At the reduced speed at which it was worked, it will be seen by the table that the engine "overran" its nominal rate to the extent of a little over 16 per cent. When, as was the case at Bury, the boiler from which the steam is obtained is of sufficient size to furnish an abundant supply without forcing the fire, "overrunning" is a decided advantage, as it lessens the loss of heat by radiation during a trial, by reducing the time during which that radiation goes on. In the case of Messrs. Clayton's fixed engine, however, the actual running time was greater than that of any of the other competitors, and the amount of overrunning was by no means excessively great.

The Reading Ironworks Company's engine, like Messrs. Clayton, Shuttleworth, and Co.'s, was a horizontal engine, with the cylinder and covers steam-jacketted, and it was fitted with a somewhat similar arrangement of slide and expansion valves, the main slide-valves, however, having the pressure taken off the back of them by rings working against faces on the steam-chest cover. To enable these rings to be applied without interfering with the expansion-valve, the main slide is in the form of a kind of skeleton box, open at the ends. The pair of main valves, one for each end of the cylinder, form the side of this box next the cylinder face, and the expansion valves work directly on the back of them, whilst the opposite side of the box carries the rings bearing against the steam-chest cover. In the Reading engine the cut-off is regulated by the governor. The workmanship of the engine was very good throughout, and it probably would have made a still better run if it had not been for one of the crank-shaft bearings running rather hot at the beginning of the trial. The fan, by which, as we mentioned last week, the draught was maintained in the chimney of the boiler, also failed for some minutes through the spindle seizing, whilst the Reading Company's engine was being tested, and thus caused the steam pressure to fall about 15lb. The fact of the cut-off being adjustable, however, enabled the engine to be kept steadily at work, notwithstanding this fall of pressure, at the expense, of course, of a certain extra expenditure of steam.

Messrs. Tuxford and Sons' engine was another good specimen of workmanship. Like those above mentioned, it is a horizontal engine. The cylinder is steam-jacketted, and the distribution of the steam is effected by a slide-valve, with expansion-valve working on the back. The engine worked very steadily and well; but the pressure of steam was rather below the mark during the whole of the trial, the average pressure probably not being more than 47lbs.

The engine sent by Messrs. Deacon and Wood, of the Kennet Ironworks, Reading, differed from any of the others exhibited, being a horizontal oscillating engine, fitted with a peculiar arrangement of valves patented by the manufacturers. The cylinder is provided on one side with faces formed on it near the end, these faces bearing against the one side of an oscillating plate, the other side of which it, in its turn, bears against fixed faces on the engine-frame. These last mentioned faces have steam and exhaust ports formed in them, which, if it were not for the interposed plate, would admit steam to and release it from, the ports in the cylinder faces in the same manner as in many oscillating engines in which the distribution of the steam is effected by the oscillation of the cylinder. The interposed plate, however, has openings formed in it; and having an oscillating motion imparted to it by an eccentric on the crank-shaft, it acts the part of an expansion-valve, and effects the cut-off at any desired point, according to the position in which the eccentric is set. The arrangement is an ingenious one but we fear that the rubbing surfaces will be

found to wear unequally, and that they will consequently be difficult to keep tight after the engine has been at work some time.

The two remaining engines, namely, that by J. J. Rawlings, of Melbourn, and that of Henry Kinsey, Nottingham, were both of the ordinary horizontal type, fitted with common slide valves and no expansion gear. They were of good plain workmanship, and construction generally. Kinsey's engine has a hollow base plate, which serves as a water heater, the exhaust steam being turned into it; and this base plate is of very neat and substantial design, as, indeed, are all the details of the engine.

Double-Cylinder Portable Engines.

In this class, as in that of the above noticed, the number of entries greatly exceeded that of the engines actually tried, the former number being ten and the latter six. The conditions of trial were somewhat different to those adopted for the fixed engines. The pressure of steam permitted was 80lb., and the power for each 9 circular inches of the combined area of the two pistons. The engines had also to be tested with two different loads, the first load being such that each engine, when working at its nominal speed, developed a dynametrical power equal to that estimated by the rule just mentioned, and the second load being 50 per cent. in excess of the first. The method of carrying out the trials was also somewhat varied. In the case of the portable engines, each engine of whatever size had an uniform quantity of 8lb. of wood and 3·2cwt. of coal weighed out to it, as much of this fuel as might be necessary being used for raising steam to the working pressure, and the remainder being weighed back, and the quantity thus returned noted. The engine to be tested being connected to the friction brake, and steam being up, the engine was started, and run as long as it could work under its load at a proper speed, care being taken that the throttle valve was full open, and that the most possible care had been taken of the fire, or, in other words, that the fire had not been allowed to become dull, with a view of allowing the steam pressure to fall, and at the same time storing up in the firebox a quantity of fuel which would be available in the ensuing trial.

When the engine had been thus "run down," a further supply of coal was weighed out to it, the quantity being, for the first or light-load series of trials, 14lb. per horse power, estimated by the society's rule, this corresponding, as we have said, in the case of the double-cylinder engines, to 14lb. for each 9 circular inches of the combined area of the two pistons. It was at first intended that the same allowance should have been made for the second series of trials; but owing to the delays which had taken place before these second trials were commenced, the allowance was, to save time, reduced to 10lb. per estimated horse power. As the load on the brake had at the same time been increased one-half, this allowance corresponded to 6 2-3lb. per dynametrical horse power developed by the engine when running at its nominal speed. The time run by each engine was calculated in the same way as in the case of the fixed engines, and the results of both series of trials, as far as the double-cylinder engines were concerned, are given by the annexed tables, Nos. I. and II.

In the first series of trials the best duty was done by Messrs. Clayton, Shuttleworth, and Co.'s engine; but in the second series this engine fell into the third place, a result to a great extent due to the fire having become clinkered up during the early part of the trial. The engine was in fact short of steam during the whole of the second experiment, and the pressure rarely exceeded 77lb. Like the stationary engine by the same firm, Messrs. Clayton's double-cylinder portable engine is well designed, and the workmanship is of the best class throughout. The cylinders are steam jacketted, and are moreover placed in the upper part of the smokebox where the exterior of the jackets are exposed to the hot escaping gases. This arrangement has been long used by these makers with very good results. The cylinder covers are also jacketted. In their engines tried this year, Messrs. Clayton and Co. have added a steam dome placed on the top of the firebox casing, the steam for the cylinders being taken from this dome. The steam jackets have a separate communication with the boiler, and from their position they must to some extent act as superheaters. The position of the cylinders also allows of the exhaust being conducted away directly. The arrangement of slide and expansion valve used on both Messrs. Clayton's portable engines tested at Bury was the same as that employed on their stationary engine, and the eccentric working the expansion valve was shifted after the completion of the first series of trials, so that both their engines worked with a later cut-off when driving the heavier than they did when working under the lighter load. In connection with their portable engines Messrs. Clayton used a feed-water heater, into which a portion of the exhaust steam was turned. This heater consists of a wooden box fitted with connections for the steam-pipe leading from the exhaust and for the pump suction pipe. That portion of the exhaust steam which is not condensed by contact with the water entering the top of the box passes up through a number of small tubes, almost closed at their upper ends, and surrounded by a larger tube having a bell-mouth at its upper end. Into this tube the water to be heated was constantly poured by hand during the trials at Bury, this water absorbing a portion of the heat from the steam escaping through the small pipes, before it entered the box, and was brought directly in contact with the exhaust steam. The arrangement is very effective, the water being heated very nearly to the boiling point; but in regular practice it would, of course, be impracticable to keep a man employed pouring in the water a canful at a time, as was done during the trials. For regular work, therefore, Messrs. Clayton omit that portion of the apparatus which necessitates the hand-feeding, at the same time sacrificing a few degrees of temperature imparted to the water.

Messrs. Ransomes and Sims's double-cylinder portable engine was of the same class as that exhibited by them at the Paris Exhibition. The cylinders and covers are steam-jacketted, and the slide-valves have the pressure taken off the back by rings working against the steam-chest covers. The arrangement of main slides and expansion-valves is, in fact, very similar to that which we have already described as being used by the Reading Company, but instead of the back of each valve being fitted with four small rings, one large ring only is employed—a more simple arrangement. One of the main features of Messrs. Ransome and Sims's engines is their feed-water heater, which is neatly arranged in the smoke-box. This heater consists of a copper vessel of ⊂ form, the top of this vessel being connected with the exhaust by a short pipe. The pump with which each engine is fitted has two independent barrels and plungers, both of the same size, one of these pumps lifting the water from the supply-tub and delivering into the heater, and the other drawing it from the heater and forcing it into the boiler. The water raised by the first pump is delivered into the heater through a perforated pipe, which throws it in fine streams through the exhaust steam as the latter enters the heater. The pumps are fitted with a very neatly designed arrangement of cock, by which the supply of water to the boiler can be regulated, and which enables either hot or cold water to be pumped into the latter at pleasure. During the trials at Bury, Messrs. Ransome's engines ran very steadily, and did their work well.

Messrs. Tuxford and Sons' double-cylinder engine was chiefly remarkable for the great size of the boiler, which far exceeded that of any of the other engines. The cylinders, which were placed horizontally on the top of the fire-box, were steam-jacketted, and the slide valves had expansion valves working on their backs. The arrangement of feed-water heater employed was similar in principle to that used by Messrs. Clayton, and the temperature of the feed was generally from 200° to 210°.

The double-cylinder engine submitted for trial by Messrs. Brown and May was one of their ordinary engines without special "racing" appliances, and considering this, its performance was exceedingly good. The cylinders, which were cast together and placed on the firebox with the steam chests outside, as in Messrs. Ransomes's engine, were not steam-jacketted, and the slide-valves were of the ordinary kind, there being no separate expansion-valve. The feed-water was heated by turning a portion of the exhaust steam into the vessel from the suction-pipe of the pump was led. In the course of the second trial the belt connecting the engine to the brake came off twice, and this caused some loss of time, and no doubt lessened to some extent the duty that would have been performed.

Single-Cylinder Portable Engines.

The trials of the single-cylinder portable engines were conducted in precisely the same manner as those of the engines with two cylinders; but the pressure of steam allowed was only 50lb. per square inch, and in giving out the allowances of coal, and proportioning the loads on the brakes, the power of each engine was estimated at the rate of one horse power for each ten circular inches of piston area. The single-cylinder engines, like those with two cylinders, were each tested with two loads, the second being 50 per cent. greater than the first; and the results of the two series of trials are given in the annexed tables, Nos. III. and IV. We shall make a few remarks upon the engines in the order in which they stand in the first of these two tables; but the space at our disposal will not allow us to do more than touch upon some of the more prominent features.

The single-cylinder engines exhibited by Messrs. Clayton, Shuttleworth, and Co., Messrs. Tuxford and Sons, Messrs. Ransome and Sims, and Messrs. Brown and May, practically embodied the same principal features of construction as the double-cylinder engines by the same firms, and as we have already alluded to these features, it will be unnecessary for us to say more about them.

In their single-cylinder portable engine the Reading Company have embodied most of the features of their fixed engine already mentioned. The expansion-valve, however, is not acted on by the governor, but it is adjustable by hand whilst the engine is running. Towards the end of the first trial the engine was, by thus altering the degree of expansion, kept running until the pressure of steam in the boiler fell to 18lb. In the second trial the expansion-valves were not touched after the engine was started. The duty performed by this engine on its second trial was the greatest performed by any of the engines tested, the consumption of coal per dynametrical horse-power per hour being, as will be seen by referring

TABLE No. I.—PORTABLE ENGINES WITH DOUBLE CYLINDERS.—1ST SERIES OF TRIALS.

MAKER'S NAME.	Nominal power by maker's rule.	Power by Royal Agricultural Society's rule.	Size of Cylinders.		Average dynametrical power developed during trial.	Nominal speed of engine in revolutions per minute.	Average speed of engine during trial in revolutions per minute.	Actual time run.		Mechanical time run = total number of revolutions ÷ nominal speed.		Period of admission of the steam in parts of the stroke.	Consumption of coal per dynametrical horsepower per hour.
			Diameter.	Stroke.									
			in.	in.				hrs.	min.	hrs.	min.		lbs.
Clayton, Shuttleworth, and Co.	12	15·12	8¼	12	17·79	110	125·3	4	0	4	42½	1/6	2·97
Ransomes and Sims	12	15·12	8¼	12	16·44	120	134·4	3	19¼	3	43¼	1/8	3·76
Tuxford and Son's	14	14·22	8	12	14·12	125	123·8	3	30	3	28	1/6	4·04
Brown and May	12	12·5	7½	12	13·21	130	137·4	3	11	3	22	...	4·15

TABLE II.—PORTABLE ENGINES WITH DOUBLE CYLINDERS.—2ND SERIES OF TRIALS.

MAKER'S NAME.	Nominal power by maker's rule.	Power to which the engine was to be tested according to the Royal Agricultural Society's rules.	Size of Cylinders.		Average dynametrical power developed during trial.	Nominal speed of engine in revolutions per minute.	Average speed of engine during trial in revolutions per minute.	Actual time run.		Mechanical time run = total number of revolutions ÷ nominal speed.		Period of admission of the steam in parts of the stroke.	Consumption of coal per dynametrical horse power per hour.
			Diameter.	Stroke.									
			in.	in.				hrs.	min.	hrs.	min.		lb.
Tuxford and Sons	14	21·33	8	12	...	125	...	...		2	6	...	3·17
Ransomes and Sims...........................	12	22·18	8¼	12	26·93	120	144·7	1	38	1	59	abont ⅕th	3·35
Clayton, Shuttleworth, and Co.	12	22·18	8¼	12	26·11	110	129·4	1	30½	1	46½	...	3·75
Brown and May	12	18·65	7½	12	...	130	...	...		1	30½	...	4·42

TABLE III.—PORTABLE ENGINES WITH SINGLE CYLINDERS.—1ST SERIES OF TRIALS.

MAKER'S NAME.	Nominal power by maker's rule.	Power by the Royal Agricultural Society's rule.	Size of Cylinders.		Average dynametrical horse power developed during trial.	Nominal speed of engine in revolutions per minute.	Average speed of engine during trials, in revolutions per minute.	Actual time run.		Mechanical time run = total number of revolutions ÷ nominal speed.		Period of admission of the steam in parts of the stroke.	Consumption of coal per dynametrical horse power per hour.
			Diameter.	Stroke.									
			in.	in.				hrs.	min.	hrs.	min.		lb.
Clayton, Shuttleworth and Co.............	8	8·1	9	12	11·03	120	163·4	3	17½	4	29	7/24	3·12
Tuxford and Sons	8	8·1	9	12	8·26	125	127·4	3	51½	3	56	¼	3·55
The Reading Ironworks Company	10	10	10	18	10·05	120	123·5	3	5¼	3	10	...	4·42
Ransomes and Sims	10	10	10	13	10·37	150	155·5	3	1¾	3	4¼	⅕	4·55
W. Allchin and Son	8	8·1	9	14	7·93	120	117·6	3	1	2	58½	...	4·7
Brown and May	8	8·1	9	14	9·55	120	141·6	2	22½	2	48¾	...	4·97
Holmes and Sons	8	8.55	9¼	14	8·55	...	...	2	44	2	44	...	5·12
Marshall, Sons Co.	8	7·87	8⅞	12	...	130	...	...		2	29	...	5·63
Ruston, Proctor and Co.	8	9·5	9¾	12	9·8	120	123·8	2	20	2	26	...	5·75
Barrows and Carmichael	7	7·22	8½	13	7·65	120	127·1	2	7½	2	15	...	6·22
Charles Burrell	8	8·1	9	14	8·9	125	131·2	1	59	2	5	...	6·72
Riches and Watts	8	7·65	8¾	12	6·88	120	108;	2	15	2	1½	...	6·91
Catchpool and Thompson	8	8·55	9¼	12	9·64	120	135·4	1	47	2	0¾	...	6·95
E. R. and F. Turner	10	10	10	12	...	130	...	...		1	51½	...	7·53
Nalder and Nalder	7	6·4	8	12	6·18	220	212·5	1	53	1	49¼	½	7·69
Philip and Henry Philip Gibbons	7	7·43	8⅝	13	7·69	125	129·3	1	31	1	34¼	...	8·91
W. S. Uuderhill	6	6·4	8	12	6·66	120	125	1	24	2	27½	...	9·6
William Pickford Wilkins	8	6·4	8	12	5·88	145	133·4	1	30½	1	24	...	10
Frederick Savage.............................	8	8·32	9⅛	12	8·51	130	134·2	1	3½	1	5	...	12·92

TABLE No. IV.—Portable Engines with Single Cylinders.—2nd Series of Trials.

Maker's Name.	Nominal power by maker's rule.	Power to which the engine was to be tested, according to the Royal Agricultural Society's rules.	Size of Cylinders. Diameter.	Size of Cylinders. Stroke.	Average dynametrical horse power developed during trial.	Nominal speed of engine in revolutions per minute.	Average speed of engine during trials in revolutions per minute.	Actual time run. hrs.	Actual time run. min.	Mechanical time run = total number of revolutions ÷ nominal speed. hrs.	Mechanical time run. min.	Period of admission of the steam in parts of the stroke.	Consumption of coal per dynametrical horse power per hour.
			in.	in.				hrs.	min.	hrs.	min.		lbs.
The Reading Ironworks Co.	10	15	10	18	16·06	120	128·5	2	27½	2	39¼	...	2·54
Clayton, Shuttleworth, and Co.	8	12·15	9	12	18·22	120	179·9	1	38½	2	27½	...	2·71
Tuxford and Sons	8	12·15	9	12	12	125	123·5	2	15	2	13½	...	2·98
Ransomes and Sims	10	15	10	13	14·79	150	147·9	1	48½	1	47	⅓	3·64
W. Allchin and Son	8	12·15	9	14	12·36	120	122·1	1	40	1	41¾	...	3·93
Brown and May	8	12·15	9	14	...	120	...	...		1	30½	...	4·41
Marshall, Sons, and Co.	8	11·8	8⅞	12	...	130	...	...		1	20¾	...	4·95
Barrows and Carmichael	7	10·83	8½	13	13·14	120	145·7	1	6½	1	20¾	...	4·95
Holmes and Sons	8	12·82	9¼	14	13·02	...	...	1	18	1	19¼	...	5·04
Ruston, Proctor and Co.	8	14·25	9⅝	12	14·43	120	121·6	1	14½	1	15½	...	5·29
Charles Burrell	8	12·15	9	14	12·51	125	128·7	0	58¼	1	0	...	6·66
Nalder and Nalder	7	9·6	8	12	10·89	220	249·7	0	51¾	0	58¾	½	6·8
W. S. Underhill	6	9·6	8	12	9·05	120	113·2	0	53	0	50	...	7·99

TABLE V.—Fixed Engines.

Name of Maker.	Nominal power according to maker's rule.	Power by the Royal Agricultural Society's rule.	Size of Cylinders. Diameter.	Size of Cylinders. Stroke.	Average dynametrical horse power developed during trial.	Nominal speed of the engine in revolutions per minute.	Average speed during trial in revolutions per minute.	Actual time run. hrs.	Actual time run. min.	Mechanical time = total number of revolutions ÷ nominal speed. hrs.	Mechanical time. min.	Consumption of coal per dynametrical horse power per hour.
			in.	in.				hrs.	min.	hrs.	min.	lb.
Clayton, Shuttleworth, and Co.	10	10	10	20	11·66	110	128·3	2	42	3	9	4·44
The Reading Ironworks Company	10	13·22	11½	20	14·5	100	109·6	2	13½	2	26½	5·73
Tuxford and Sons	10	10	10	14	10·57	125	132·2	2	14	2	21¾	5·92
Deacon and Wood	8	7·86	8⅞	14	7·91	110	110·6	2	10½	2	11¼	6·4
J. J. Rawlings	8	7·86	8⅞	16	8·35	115	121·5	1	41¾	1	47½	7·81
Henry Kinsey	10	10	10	16	10·98	100	109·8	1	37	1	46½	7·88

to the table, only 2·54lb. We need only say here that it speaks well for the design and workmanship of the engine, as well as for the care and judgment with which it was worked during the trial.

In Allchin's engine the cylinder is placed in the smoke-box, but it is not provided with a steam-jacket; the expansion-valve, which works on the back of the main valve, is adjustable by hand whilst the engine is running. The engine is carried on springs at the fire-box end.

The engine sent by Messrs. Marshall had a mishap on the occasion of its first trial, the nozzle having been, by some negligence, removed from the blast pipe. The consequence was, that in order to maintain steam, the jet had to be kept going a great part of the time, and the duty performed was, therefore, somewhat less than it otherwise would have been. The design and workmanship of Messrs. Marshall's engine is very good throughout. The cylinder is steam-jacketted, and the piston-rod, valve spindles, and guide bars are of steel. The feed-water is heated by turning a portion of the exhaust steam into the supply tub, and also by forcing the water through a heater placed in the upper part of the smoke-box. The boiler is strongly made, and it is intended, under ordinary circumstances, to be worked at a pressure of 80lb., the steam being then cut off in the cylinder at one-sixth of the stroke.

Messrs. Ruston, Proctor, and Co.'s engine was one of their ordinary class, and it was chiefly noticeable for strong proportions and good plain workmanship. On the completion of the first trial of Messrs. Ruston, Proctor, and Co.'s engine, some interesting experiments were made to determine the power to which the engine could be worked. For this purpose the pressure of steam was increased to 75lb. and weight added to the brake, the result being ultimately that, when running at 133 revolutions per minute, the engines developed 21½ dynametrical horse power without inconvenience, there being an abundant supply of steam. The engine was, as will be seen by the table nominally of 8-horse power only; but Messrs. Ruston, Proctor, and Co.'s employ much larger cylinders than other makers in proportion to the nominal power of their engines.

In Barrows and Carmichael's engine, the underside of the cylinder is exposed to the steam, and a steam belt, equal in width to about half the length of the cylinder, is also carried round it. The crosshead is guided by a single-slotted guide-bar placed below it. the crosshead being arranged so as to clip this bar—a simple and neat arrangement. The feed pump is of the long stroke class, and is worked from the crosshead. Riches and Watt's engine has the cylinder placed in the smokebox, but without a steam jacket. It is fitted with an expansion valve, working on the back of the main slide, and there is a steam dome on the top of the firebox casing. The feed-water is heated by a heater composed of six brass tubes placed across the smokebox. Catchpool and Thompson's and Turner's trial engines were of the ordinary class constructed by those makers.

The engine sent for trial by Messrs. Nalder and Nalder, probably in-

cluded a greater number of peculiarities of construction than any engine exhibited at Bury. It was specially intended by the makers for working at a high speed; but the design is in many respects defective. Thus the cylinder is not steamjacketted, and the distribution is effected by an ordinary slide valve cutting off at half-stroke. This lateness of the cut-off renders it necessary to wire-draw the steam considerably when the engine is running with a moderate load, and it is probable that it was this combined with want of protection for the cylinder, which made the engine take a comparatively low place in the trials at Bury. On Nalder's engine the eccentric rod, instead of being coupled to the valve-spindle by a joint and pin in the usual way, is connected to it by a flat spring, which bends to allow of the angular movement of the eccentric rod. A similar form of attachment is used for connecting the pump-rod and plunger. The safety-valve lever is formed of a spring, so that no spring-balance is required. We fear that this arrangement allows the valve to have but a very small amount of lift. The governor is of a peculiar construction, which we could scarcely explain without drawings. The balls are carried by a pair of spring arms fixed to the crank shaft, and as they open they shift a sliding collar along this shaft, the motion of the collar being communicated by an arm and light spindle to the throttle-valve. The wheels on which the engine is mounted have cast-iron bosses and rims and very light wrought-iron spokes. The rims have a number of slots cast through them, one between each spoke, these slots allowing the drags when put on the wheel being secured by bolts passed through them. When the engine is at work also it is securely fixed by connecting the top of each hind wheel to the bottom of the corresponding front wheels by means of a pair of bars placed one on each side of the wheels and secured to them by bolts passing through the slots in the rims. The engine is altogether one which will well repay examination.

Of the remaining engines those by Gibbons and Underhill are of the ordinary class; and of Savage's, which is a traction engine, we have spoken elsewhere. Wilkin's engine differs from any of the others exhibited in the peculiar shape of the fire-box, which is formed by a gradual deepening of the boiler. The latter thus has in side elevation a shape resembling that of a funnel, the barrel representing the spout and the enlarged portion the fire-box casing. The fire-box proper is thus entirely enclosed by a water casing. The back end of the boiler is secured by bolts, so that by driving back the tubes the fire-box can be taken out for the purpose of cleaning.

[We are indebted to the courtesy of the editor of "Engineering" for a copy of the report of these trials in time for publication in the present number.—Ed. Artizan.]

ROYAL INSTITUTION OF GREAT BRITAIN.

ON THE WATER SUPPLY OF THE METROPOLIS.

By Edward Frankland, Esq., F.R.S., Professor of Chemistry, R.I.

(*Continued from page* 163.)

The organic matters containing nitrogen which occur dissolved in water, are chiefly, if not entirely, of animal origin, being derived either from sewage or manured land; be their origin, however, animal or vegetable, no distinction founded upon their source can be drawn between their respective noxious qualities. After admixture with spring or river water, these noxious organic matters undergo slow oxidation, by which they are finally resolved into comparatively innocuous mineral compounds; their carbon is converted into carbonic acid, and their hydrogen into water; and these products can no longer be identified in the aerated waters of the river or spring; but the nitrogen is converted into nitrous and nitric acids, which, combining with the bases contained in most waters, remain dissolved, and constitute a record of the sewage or other analogous contamination to which the water has been subject. With certain corrections, presently to be mentioned, the analytical determination of the nitrogen contained in these salts and in the form of ammonia, writes, as it were, the history of the water, as regards its contact with decomposing animal matter. Such previous organic contamination may be conveniently expressed in parts of average filtered London sewage, which, if thus completely oxidised in a river, would yield a like amount of nitrogen, in the form of nitrites, nitrates, and ammonia. For this purpose, average filtered London sewage may be taken as containing 10 parts of combined nitrogen in 100,000 parts, as deduced from the numerous analyses of Way, Hofmann, and Witt. The number so obtained as the previous sewage contamination of a water requires, however, a correction, since rain-water itself contains combined nitrogen as ammonia, nitrite of ammonia, and nitrate of ammonia. The amount of these substances present in rain which falls at Rothampstead has been most carefully determined by a laborious series of monthly analyses, made independently on the one hand by Messrs. Lawes and Gilbert, and on the other by Professor Way, and extending over two years. The results of these chemists accord well, and they give as the average amount of nitrogen in the forms of ammonia, nitrite of ammonia, and nitrate of ammonia, ·0985 part in 100,000 parts of rain-water. This must be deducted therefore from the calculated amount of previous sewage contamination of any sample of water. It corresponds to 985 parts of previous sewage contamination in 100,000 parts of the water. There is no doubt that this reduction is too large, and therefore favourable to the character of the water, since in most cases but a very small proportion of the water of a river or spring falls as rain directly into the stream; and Professor Way has proved that almost every trace of the ammonia contained in rain-water is absorbed when the water percolates through cultivated soils. Now, as three-fourths of the combined nitrogen in rain-water is in the form of ammonia, it is evident that rain-water must be deprived of much of its original nitrogenous contamination before it reaches such a river as the Thames. The very small amount of combined nitrogen found in natural waters of undoubted purity, such as that of Loch Katrine for instance, also testifies to the liberality of the above allowance. The water of Loch Katrine contains only one-third as much combined nitrogen as that present in rain falling at Rothampstead, so that, starting from the base line of purity above proposed, the water of Loch Katrine exhibits a negative previous sewage contamination equal to 575 parts in 100,000; or, in other words, it would require 575 parts of average London sewage to be added to, and allowed to oxidise in each 100,000 parts of Loch Katrine water before its purity would be reduced to the standard with which I propose to compare the metropolitan waters. It is necessary here to remark, however, that owing to the more copious rains of the Highlands of Scotland, the rain-water of that district probably contains less combined nitrogen than that which falls at Rothampstead.

The nitrogenous organic matter which has escaped the process of oxidation above described, and which therefore still exists in the water at the time the analysis is made, constitutes what may be appropriately termed the present sewage contamination of the water. The existence of this contamination is shown by the presence of organic nitrogen in the water, and its amount may be expressed by the number of parts of average filtered London sewage (of the strength above described), which if contained in 100,000 parts of pure water, would contaminate the latter with the same amount of combined nitrogen. By operating upon one litre of water for the determination of total combined nitrogen, one per cent. of sewage can be detected with certainty; but smaller per-centages ought, in operations upon such a small quantity of water, to be considered as falling within the possible errors of experiment. Thus in the table of analytical results given below, the indications of organic nitrogen, and consequently of present sewage contamination, amounting in the maximum to one-half per cent., ought to be disregarded; because as the total combined nitrogen was determined in one litre of each water, the amount of present sewage contamination indicated by the analysis falls within the limit of possible experimental error. The subjoined tabulated results obtained in the analysis of samples of the metropolitan waters collected in February last and during the present month, show therefore that none of these waters contained as much as one per cent. of present sewage contamination. This search for unoxidised sewage, or its equivalent in a water, may be rendered more minute by operating upon a larger volume of water, by which the possible error of experiment is reduced in proportional amount; thus, if ten litres of water be used for the determination of total combined nitrogen, one-tenth of a per cent. of present sewage contamination can be ascertained with certainty. This operation has been performed upon ten litres of the Thames water delivered by the Grand Junction Company, and collected during the present month; and it is satisfactory to find that this minute examination failed to detect any actual sewage contamination, consequently the sample of the Grand Junction Company's water operated upon did not contain $\frac{1}{1000}$th of its volume of unoxidised sewage. It must be consolatory to the drinker of Thames water to know that, although, according to Mr. Bateman, the population within the basin of the Thames above the points at which the water i withdrawn for the supply of London exceeds 1,000,000 persons, the drainage of some 600,000 of whom is poured into the river, the whole of this fæca matter is so completely oxidised before it reaches the water-cisterns of London, as to defy the detection of any trace in its noxious or unoxidised condition. If the average flow of Thames water just above the point at which the London companies withdraw their supply be taken at 800,000,000 of gallons daily, the drainage of 600,000 people ought to produce a sewage contamination of 2,250 parts in 100,000. It could scarcely be expected that this calculated number should approximate very closely to that obtained by the actual analysis of Thames water, since the calculated number depends upon many contingencies, as, for instance, upon the volume of water actually flowing past the points of withdrawal at the time the companies abstracted the water analysed; and, secondly, upon the greater or less retention of the fæcal matters in the sewers of the towns draining into the river: it is interesting, however, to find that the sewage contamination of Thames water, as determined by analysis, does not differ much from that calculated from the above data. The analytical table

given below shows that the average previous sewage contamination of the water delivered by the five companies drawing their supply from the Thames during the months of February and March, 1867, was 2,466 parts in 100,000 of water, the amount calculated from the number of persons draining into the river being, as just mentioned, 2,250 parts in 100,000 of water. As summer advances and aquatic vegetation becomes vigorous in the bed of the Thames and its tributaries, this coincidence of calculated and analytical results will doubtless be disturbed; as the water plants can scarcely fail to withdraw an appreciable amount of nitrates and nitrites from the water, thus diminishing the amount of combined nitrogen, and consequently of previous sewage contamination, as determined by analysis.

The second important class of impurities contained in water used for domestic purposes consists, as above mentioned, of certain mineral salts which possess the power of decomposing soap. These substances are the hardening or soap-destroying constituents of waters; from a purely sanitary point of view they are of less direct importance than the organic impurities, still by rendering efficient ablution and thorough cleanliness difficult of attainment, they doubtless indirectly affect the health of communities supplied with waters in which they are present in considerable quantities. The chief hardening ingredients in potable waters are the salts of lime and magnesia. These salts decompose soap, forming curdy and insoluble compounds containing the fatty acids of the soap, and the lime and magnesia of the salts. So long as this decomposition goes on, the soap fails to produce a frothiness in the water, and is useless as a detergent; but when all the lime and magnesia salts have been decomposed by the action of the soap, the slightest further addition of the latter produces a lather when the water is agitated, but this lather is again destroyed by the addition of a further quantity of the hard water. Thus the addition of hard water to a solution of soap, or the reverse of this operation, causes the production of the insoluble curdy matter above mentioned. Bearing this in mind, it is easy to understand the process of washing the skin with soap and hard water, which may be thus described:—1st, the skin is wetted with the water, then soap is applied; the latter soon decomposes all the hardening salts contained in the small quantity of water with which the skin is covered, and there is then formed a strong solution of soap which penetrates into the pores of the skin. This is the process which goes on whilst a lather is being produced in washing, but now the lather requires to be removed from the skin. How can this be done? Obviously, only in one of two ways, viz., by wiping it off with a towel, or by rinsing it away with water. In the former case the pores of the skin are left filled with soap solution, in the latter they become plugged up with the greasy curdy matter which results from the action of the hard water upon the soap solution occupying the pores of the cuticle. As the latter process of removing the lather is the one universally adopted, the operation of washing with soap and hard water is perfectly analogous to that used by the dyer or calico-printer when he wishes to fix a pigment in the pores of any tissue. He first introduces into the tubes of the fibre of calico, for instance, a liquid containing one of the ingredients necessary for the formation of the insoluble pigment, this is followed by another liquid containing the remaining necessary ingredients; the insoluble pigment is then produced within the very tubes of the cotton fibre, and is thus imprisoned in such a manner as to defy removal by subsequent washing. The process of ablution, therefore, in hard water, is essentially one of dyeing the skin with the white, insoluble, greasy and curdy salts of the fatty acids contained in soap. The pores of the skin are thus blocked up, and it is only because the insoluble pigment produced is white that such a repulsive operation is tolerated. To those, however, who have been accustomed to wash in soft water, the abnormal condition of the skin thus induced is for a long time extremely unpleasant.

Nevertheless, opinion is not quite unanimous as to the advantages of soft water over hard: some persons consider hard water to be necessary for the supply of the calcareous matter of the bones; others believe soft water to be peculiarly liable to attack and dissolve the lead of the pipes through which it is conveyed, or of the cisterns in which it is stored.

An examination of the grounds upon which these opinions are based would completely refute them; but the limits of this discourse do not permit of such a digression, and I must therefore content myself with a mere allusion to one or two facts in connection with them. First, as to the necessity of hard water for the supply of the calcareous matter of bones. If it be assumed that a man drinks daily half a gallon of Thames water, he obtains from it 3¼ grains of lime, chiefly in the form of chalk. This amounts to not quite three ounces per annum, which does not seem to be a very large contribution to bony matter. Now, suppose the use of this water to be discontinued, and that no part of it is replaced by bitter beer, which always contains far more lime in a given volume than Thames water, but we will assume that the individual consumes one-third of a pint of milk per day, he then receives in this quantity of milk more lime than his system can acquire from two quarts of Thames water. Then as to soft water attacking and dissolving lead and thus becoming poisonous, it is by no means true, as a general proposition, that soft water does attack and dissolve this metal. The very soft water of Loch Ness, as supplied to Inverness, does not attack lead, as evidenced by the condition of the lead pipes which I now produce, and through some of which that water flowed for six years; neither does the soft water of Ennerdale Lake, supplied to Whitehaven, attack lead. Even those soft waters which do attack the metal, such as those now supplied to Glasgow and Manchester, only do so when the surface of the lead is clean and bright. The action soon ceases; in fact, as soon as the metal becomes tarnished the pipes are protected; and no complaints of any symptoms of lead poisoning have, for the past ten years, been heard from these large cities. Lastly, a sample of very soft water, taken from one of the principal streams from which it is proposed to supply London, has no action even upon clean and bright lead. Notwithstanding the numerous researches made in connection with this subject, the causes of the attack of lead by water have not yet been completely elucidated; it has, however, been established that the presence of oxygen and the comparative absence of carbonic acid in the dissolved gases are essential conditions to this action. Messrs. Graham, Miller, and Hofmann, in their report on the Metropolitan Waters in 1851, first showed that carbonic acid, when dissolved in water, was a complete protection against lead contamination, and from a series of experiments recently made I find that two volumes of carbonic acid dissolved in 100 volumes of water, completely protect even distilled water from such contamination. Rain water as it descends to the earth dissolves atmospheric gases, and this solution is afterwards continued in brooks and rivers. Of the chief atmospheric gases carbonic acid is by far the most soluble; 100 volumes of pure water can dissolve 100 volumes of this gas; oxygen, on the other hand, only dissolves to the extent of three volumes in 100 volumes of water. Nevertheless, owing to the much larger proportion of oxygen than of carbonic acid in atmospheric air (500:1), water takes up oxygen more rapidly than carbonic acid, and hence freshly fallen rain water acts upon lead; but when the water flows a great distance through an open conduit, the carbonic acid absorbed finally reaches the protecting proportion, and the action upon lead ceases, although the water retains its original softness. Hence there is no necessary connection between soft water and lead corrosion. Even distilled water, left in contact with the air, for some time, loses its property of acting upon lead.

The third class of impurities present in potable waters, viz., matters which are not expelled at a red heat, and which do not decompose soap, require no detailed notice; they consist chiefly of salts of the alkali metals, such as the sulphates and chlorides of potassium and sodium. Unless present in excessive quantity they are innocuous, both as regards the internal and external use of the water.

The numbers in columns 2, 3, 4, 5, 6, 7, 8, and 9, all relate to 100,000 parts of the waters. Column No 2 shows the total solid impurity contained in each water as delivered from the Company's mains. No. 3 gives the amount of carbon contained in the organic matter present in this solid impurity. No. 4, the amount of nitrogen in the form of salts of nitric and nitrous acids. Column No. 5 shows the amount of ammonia present in each sample, and column No. 6 records the total amount of nitrogen in the several forms of nitrogenous organic matter, salts of nitric and nitrous acids and ammonia, whilst column No. 7 exhibits the previous sewage contamination estimated as above described. Column No. 8 shows the hardness of each water as estimated by the soap test; that is, the number of parts of carbonate of lime, or its equivalent of other hardening salts contained in 100,000 parts of the water. Finally, column No. 9 gives the amount of soap which it is necessary to add to 100,000 parts of each water before a lather can be produced, this amount of soap being thus wasted or destroyed in decomposing the hardening constituents of the water. It is usual to call each part of carbonate of lime or its equivalent of other hardening material in 100,000 parts of water, a *degree of hardness*.* Each degree of hardness indicates the destruction of twelve parts of the best hard soap by 100,000 parts of water.

As an example of the mode of reading the above table, we may take the Chelsea Company's water, 100,000lbs. of which contained, in the month of February last, 28·58lbs. of solid impurity; the organic matter constituting a portion of this impurity contained 0·433lbs. of carbon. This solid impurity also contained 0·337lbs. of nitrogen in the shape of nitrates and nitrites, besides 0·004lbs. of ammonia; whilst the total amount of combined nitrogen in every form was found to be 0.371lbs. The above quantity of water as supplied by the Chelsea Company had been, after its descent to the earth as rain, contaminated with sewage or manure matter equivalent to 2,420lbs. of average London sewage. By gradual oxidation, partly in the pores of the soil, partly in the Thames and its tributaries, and partly in the reservoirs, filters, and conduits of the Chelsea Water Company, this sewage contamination had been entirely converted into comparatively innocuous inorganic compounds before its delivery to consumers. Finally, 100,000lbs. of the said water contained 16·2lb. of carbonate of lime, or their equivalent of other hardening ingredients; whilst, if the water were used for washing, 100,000lbs. of it would occasion the waste of 194·4lbs. of the best hard soap.

* The degree of hardness more usually employed by chemists is that first proposed by Dr. T. Clark, viz., one grain of carbonate of lime or its equivalent, in one imperial gallon of water, or one part in 70,000 of water. The degrees in the above table harmonise better with the decimal arrangements of the rest of the analytical results; they are readily converted into Clark's degrees by multiplying by 7, and then moving the decimal point one place to the left.

We are now in a position to understand the following table, which contains the results of the analytical examination of the waters supplied to the metropolis during the past two months:—

Quality of the Waters supplied to the Metropolis during the months of February and March, 1867.

1	2		3		4		5		6		7		8		9	
Names of Companies.	Total solid impurity in 100,000 parts of Water.		Organic Carbon.		Nitrogen as Nitrates and Nitrites.		Ammonia.		Total combined Nitrogen.		Previous Sewage contamination.		Hardness.		Soap destroyed.	
	Feb.	Mar.	Feb.	Mar.	Feb.	Mar.	Feb.	Mar.	Feb.	Mar.	Feb.	Mar.	Feb.	Mar.	Feb.	Mar.
Thames.																
Chelsea	28·58	30·96	·433	·185	·337	·352	·004	·004	·371	·355	2420	2565	16·2	18·3	194·4	219·6
West Middlesex	28·68	30·26	·340	·245	·356	·313	·006	·008	·412	·319	2630	2205	16·2	18·9	194·4	226·8
Southwark and Vauxhall	29·08	31·22	·293	·256	·357	·344	·005	·005	·361	·348	2630	2495	16·8	19·1	201·6	229·2
Grand Junction	29·44	31·54	·417	·311	·322	·345	·004	·004	·325	·348	2270	2495	17·1	19.4	205·2	232·8
Lambeth	29·36	32·10	·423	·289	·341	·341	·005	·008	·356	·347	2470	2485	16·0	18·5	192·0	222·0
Other Sources.																
New River	29·72	27·70	·272	·284	·350	·332	·003	·004	·396	·335	2540	2365	18·5	16·8	222·0	201·6
East London	33·56	30·36	·293	·270	·357	·320	·004	·004	·392	·323	2620	2245	18·8	18·3	225·6	219·6
Kent	39·84	39·90	·088	·114	·421	·417	·008	·004	·428	·420	3300	3215	23·1	23·0	277·2	276·0
South Essex	38·32	37·68	·143	·185	·844	·851	·007	·005	·850	·855	7520	7565	21·1	21·4	253·2	256·8
Water from Loch Katrine as supplied in Glasgow	3·28	—	·256	—	·031	—	·002		·041	—	0	—	·3	—	3·6	

For the purpose of comparison I have also appended to the above table the results yielded by Loch Katrine water, as delivered in Glasgow, when submitted to the same analytical processes. A glance at the table will show how vastly superior is the quality of this water as compared with the best at present supplied to London; 100,000lbs. of this water contain but 3·28lbs. of solid impurity; it has no sewage contamination, previous or present, and it has only 0·3 degree of hardness, occasioning the destruction of only 3·6lbs. of soap by 100,000lbs. of the water.

Such is the chemical history of the water at present supplied to the metropolis; and it must be borne in mind that, grave as are its defects, the mode of the delivery of this water to consumers is still more defective. That in a densely-populated city, water should be delivered only once and for a few minutes in twenty-four hours, and not at all on Sundays, is a condition of things utterly incompatible with the supply of wholesome and palatable water. Even if the water of Loch Katrine itself were delivered in London according to the system at present adopted by the metropolitan water companies, it would infallibly be rendered unfit for human consumption after twenty-four hours' exposure to the vile atmosphere and sewer gases in which the water cisterns of London are systematically placed.

The fundamental defects of our present water supply may be thus summed up:—

1. Great previous sewage contamination.
2. Liability to present sewage contamination.
3. Great hardness.
4. Intermittent supply.

Quality of the proposed Metropolitan Water Supply.—The waters from the sources of the Severn and from the Cumberland Lakes have not yet been submitted to the above analytical processes, and it is therefore impossible to compare them in all respects with the present metropolitan supply. The water of the Bala Lake, in North Wales, which may be regarded as similar to that which would be supplied by Mr. Bateman's scheme, was examined by the late Dr. R. D. Thompson, and the waters of the Cumberland Lakes have been more elaborately investigated by Professor Way. From the analyses of these chemists the following numbers are calculated:—

	Total solid impurity in 100,000 parts.	Hardness.	Soap destroyed.
Bala Lake	2·97	1°·1	13·2
Hawes Water	5·70	2°·9	34·8
Ullswater	5·94	3°·0	36·0
Thirlmere	5·16	2 ·1	25·2

A comparison of these numbers with those given in the previous table exhibits the great superiority of the proposed waters over those at present supplied to London as regards total solid impurity and soap-destroying ingredients, whilst it can scarcely be doubted that waters obtained from such sources will be as free from deleterious organic contamination as that of Loch Katrine.

Amelioration of the present Water Supply.—In the event of a new source of water supply being at once determined upon, at least seven years must elapse before it can be rendered available to the metropolis; it therefore becomes important to inquire how far it is possible in the interim to ameliorate our present supply. The first and most obvious improvement would be the substitution of the *constant* for the *intermittent* system of delivery. With certain restrictions, all the metropolitan companies express their willingness to make this change, and with the unanimity of opinion regarding its advisability it is difficult to account for the delay in effecting it, unless it arise from the paltry cost involved in the alteration of the present fittings, which would fall upon the landlords of small tenements. Most towns of importance in Great Britain have been long supplied with water on the constant system; why, then, is this boon denied to London, where it is much more urgently required? Until this alteration is effected, it is, for the bulk of the population, almost useless to improve the quality of the water. Where a supply for one or even two days has to be stored in a filthy butt, exposed to the foul atmosphere of a crowded court or alley, good and wholesome water can never reach the lips of the consumers.

The most formidable danger arising from the use of the present water supply is undoubtedly the liability to actual sewage contamination, such as that which there is every reason to believe destroyed so many lives in the east of London last summer. How can we best protect ourselves against this noxious contamination? The answer is, there is no absolutely reliable protection. Filtration through animal charcoal is perhaps the best safeguard; but I have shown that this process fails to remove from water the matter which is believed to constitute cholera poison. Permanganate of potash is also an excellent purifier of water, but there is not the slightest evidence that this agent can destroy cholera poison. Boiling the water for a short time is no guarantee that its noxious qualities are destroyed; for, even on the very probable supposition that cholera and other similar poisons are organic germs, we know that many such germs, especially those which are of a low type, retain their vitality after being boiled in water or even after exposure to a temperature of 248° F. for a considerable time. The late Dr. Lindley mentions the fact of raspberry seeds germinating after being boiled for jam; and as syrup boils at a higher temperature than water, these seeds must have been exposed to a heat considerably higher than that of boiling water. Nearly twenty years ago a curious red fungus or mould (*Oïdium aurantiacum*) attacked the bread of Paris. M. Payen exposed pieces of bread, upon which spores of the fungus had been sown, for half an hour to 248° F. in tubes; the red fungus afterwards germinated, although its vitality was destroyed when the temperature was raised to 284° F. I have undoubted evidence of the production of violent cramps and diarrhœa by the drinking of tea made from water which, previous to boiling, had become contaminated with sewage

Nevertheless, whilst none of these methods can be *relied upon* for the destruction of noxious organic matter in water, I am far from wishing to discourage their use as measures of precaution. More especially would I recommend filtration through animal charcoal as a most undoubted and valuable means of greatly reducing the amount of organic matter in water. I find that water will readily pass through a stratum of animal charcoal 3ft. thick, at the rate of 41,472 gallons per day per square foot, the oxidisable organic matter contained in the water being reduced to one-half. 5,00 tons of animal charcoal would be

an ample quantity through which thus to pass the whole of the present metropolitan water supply. This at £13 per ton would cost £6,500. This charcoal would require to be heated to redness in retorts or ovens, for a couple of hours every sixth months. It would last for two years, and would then be worth nearly half its original cost as manure.

With regard to the excessive hardness of the London waters, it does not appear that any practicable scheme of amelioration can be contrived. Some twenty years ago a beautiful and very simple process of softening hard waters by the addition of lime was devised by Dr. Clark, of Aberdeen; but although this process has repeatedly been tried by water companies, it has invariably been again abandoned, since, notwithstanding the cheapness of the material employed, the amount of carbonate of lime deposited by the London waters when submitted to this treatment was, in the case of such vast volumes of water, so enormous as to cause the process to be pronounced impracticable. It is to be feared, therefore, that we must for the present be content to block up the pores of our skins with the greasy curd of hard water; but it is very desirable that the other ameliorations of which I have spoken should be carried out at once, although they ought not to delay the introduction of a water-supply free from sewage contamination. Such a supply is a priceless boon to a community; and relying upon our experience in other cities, it is not too much to hope that its introduction into London would be the means of banishing for ever *epidemic* cholera from the capital of this country.

CHEMICAL SOCIETY.

ON THE ALLOYS OF MAGNESIUM.

By James Parkinson.

Magnesium combines very energetically at high temperatures with phosphorus, arsenic, and sulphur, with which it forms remarkably unstable compounds. The coherent and difficult fusible alloys of magnesium with phosphorus and with arsenic, oxidise rapidly, and fall to powder when exposed for a short time only to the air at common temperatures, the alloy of sulphide of magnesium only slowly.

The apparatus used for the experiments with phosphorus and arsenic was made from a stout half-inch diameter glass tube, of difficult fusible glass, such as is used in organic analysis. The two ends of a piece of a combustion-tube (eight inches long) were drawn out to about a quarter of an inch in diameter and four or five inches long, and the middle part blown out into two bulbs of about three-quarters of an inch in diameter. The two ends were bent upwards, at an angle of about 30 degrees, and the larger orifice of one of the ends was connected to a hydrogen apparatus by an india-rubber connecter, after placing the substances in the bulbs; and then, after displacing the atmospheric air in the tube by a rapid and dry current of hydrogen, the bulbs were heated by means of the gas flame of two or more good air-burners. The current of hydrogen was continued after withdrawing the flame of the burners until cold, and the product was weighed immediately.

Phosphorus and Magnesium.

Pieces of phosphorus were placed in one bulb and magnesium filings in the other. The experiment was conducted as above described, and the melted phosphorus was allowed to flow slowly, by inclining the tube over the magnesium filings heated to dull redness. Then the flame of another burner was used, with a view of maintaining uniformity of temperature, and for volatilising the excess of phosphorus from the tube. The combustion which took place at a dull red heat was highly luminous and vivid, and the tube was corroded and fractured in several cases from the sudden increase of heat during combustion. With 3grs. magnesium filings the increased weight was in the first experiment 2·45grs., in the second 1·98grs., and in the third 2·08grs. The product is a hard, brittle, coherent, semi-metallic and difficulty fusible mass, of a dark brown colour, with a fibrous crystalline fracture; it is immediately tarnished on exposure to the air, and within a few hours falls to a flocculent powder, at the same time undergoing several changes of colour. It first becomes brownish-black, then brown, yellowish, straw-yellow, and finally yields a permanent greyish-white powder, emitting non-inflammable phosphoretted hydrogen during its oxidation, as well as when thrown into water, or dilute hydrochloric acid. The freshly oxidised product, when heated to dull redness, in an open tube, undergoes combustion, and becomes whiter in colour. It is completely dissolved by dilute hydrochloric acid.

A paper on phosphide of magnesium, by Mr. Blunt, is published in the "Chemical Journal" for 1865 [2], iii., 106, the results of which do not coincide with the above. The black powder, said to be a phosphide of magnesium, and described as a very stable compound, is probably carbon, mixed with some phosphide of magnesium, the carbon to which it owes its blackness being probably deposited by the reaction of magnesium upon the carbonic acid used in the experiment. In all cases magnesium decomposes the glass in which the experiments are conducted, and is stained black by the reduction of the silicium of the glass, with which it combines and forms a silicide. Oxygen is also liberated at the same time, which combines with the magnesium, and probably with the phosphorus also. See the reaction of magnesium upon carbonic acid, and also upon carbonates further on.

Sulphur and Magnesium.

In combining sulphur with magnesium, a single bulb-tube, constructed as before described, was connected with a small flask containing sulphur used for generating sulphur-vapour; the magnesium filings, mixed with a little sulphur, gave better results than sulphur-vapour alone. The heat was slowly raised to dull redness by means of the gas flame of a good air burner. The product was a brownish-black, scoriaceous, coherent coke-like mass, hard and brittle, and mixed with a little oxide of magnesium, and some undecomposed filings. On exposure for some time to the air, the difficulty fusible sulphide slowly tarnishes, and evolves sulphuretted hydrogen, and the finely granular and bright steel-grey fractures become dull, and coated with a greyish oxide; it is partly soluble, with straw-yellow coloration in water, with evolution of sulphide of hydrogen, but on exposure to light it deposits sulphur and becomes colourless.

Arsenic and Magnesium.

The single bulb-tube was connected with a hydrogen apparatus, through which a rapid current of pure dry hydrogen was passed; and when all the atmospheric air was displaced thereby, the magnesium filings, mixed with arsenic, placed in the bulb part, were heated slowly to redness. In one experiment, 3grs. magnesium filings, mixed with 15grs. arsenic, gave violent and vivid combustion, with evolution of much heat. The heat was continued until the hydrogen flame at the orifice of tube ceased to be luminous; the current of hydrogen was passed through until the ignition tube was cold, and then the product was immediately weighed. The loss was found to be 8·8grs., showing that about 6·2grs. arsenic were fixed and combined with 3grs. magnesium. 3grs. magnesium heated in like manner for ten minutes, lost only 0·05grs., hence the 8·8grs. lost were almost entirely due to the volatilisation of arsenic. The product was a hard, brittle, and difficulty fusible mass, of a chocolate-brown colour and dull lustre, with finely grained fracture, and a brown sub-metallic lustre; it crumbled up, in a few hours, into a dark brown powder.

The same quantity of magnesium filings and arsenic, suddenly heated in a glass test-tube over the flame of a good air-burner, gave a vivid and violent action, slightly explosive. Another experiment with 3grs. magnesium and 20grs. arsenic gave an explosion with loud report, and shattered the bottom of the test-tube into fine fragments.

Behaviour of Magnesium with Oxides and Carbonates.

The de-oxidising action of magnesium at high temperatures is less violent than its combination with the non-metallic elements, but sufficient to give a vivid combustion, which occurs at a slightly higher temperature.

Pure lime is decomposed at a red heat by magnesium filings, with only a slow and dull combustion, and yields a straw-yellow powder, which has a fetid smell, and decomposes water slowly.

Pure alumina, heated to redness with magnesium filings gives a vivid combustion, and a blackish-brown powder, which rapidly decomposes water, and gives a violent action with moderate dilute hydrochloric acid, sufficient in one experiment to ignite the hydrogen evolved in the reaction.

Sesquioxide of chromium, heated to redness with magnesium filings, gives a vivid combustion and a black powder, which decomposes water. The inside of a glass tube, in which some small fragments of magnesium were heated with chromic oxide, was coated with a thin white metallic coat, which, when washed and scraped clean, gave a silver-white lustre, and on ignition in the air burnt with evolution of much light and gave a greenish-yellow oxide—indicating the reduction of the oxide to the metallic state—and combined with the magnesium, and, probably, also with silicium derived from the tube.

Titanic acid, heated to redness with magnesium filings, gives a vivid combustion and a bluish-black, gritty powder, partly, if not wholly, insoluble in cold dilute hydrochloric acid, which, when dried and heated in the open tube, burns like tinder, and when thrown into the flame emits bright red scintillations.

Magnesia (pure and free from carbonic acid), heated with magnesium-filings at a red heat, is not acted upon, but the carbonate gives a slow combustion, with deposition of carbon and a brownish-black powder; so also do other carbonates.

Silica, heated to redness with magnesium-filings, gives a vivid reaction, and a brown to bluish-black powder according to the degree of heat and vividness of reaction; if the silicium is in excess, and the combustion slow, the product is brown; but, if the magnesium is in excess, and the combustion vivid, the product is a black, gritty brown; which, in the latter case, gives a much stronger reaction when thrown into hydrochloric acid, and evolves more silicide of hydrogen and with louder detonation as the gas spontaneously ignites in the air—hence a "silicide of magnesium" is formed in greater quantity in one case than in the other. The black powder contains the most silicide. The lighter coloured product probably contains more of anhydrous silicate of magnesia. One part magnesium-filings to two parts silica, heated in a current of hydrogen (in fine powder), give a brown gritty powder. Equal parts magnesium and silica give a more cemented and brownish-black powder: and with three parts magnesium and one part of silica the product was a bluish-black powder with sub-metallic lustre, hard and brittle. When the darkest coloured products are thrown into concentrated sulphuric acid, no spontaneously inflammable gas is evolved until the substance is rubbed with a glass rod against the sides of the tube, and then no detonation takes place, but luminosity only is emitted. Similar results are obtained, when the blackened part of the glass tube in which magnesium has been heated, either alone or with other substances, is broken up into fine fragments and thrown into either dilute or strong hydrochloric acid, evidencing the presence of silicide of magnesium from the reaction of magnesium upon the glass. The same powerful deoxidisation and production of silicide of magnesium takes place also with silicates when heated to redness with magnesium.

Behaviour of Magnesium with Oxides of Carbon.

Carbonic oxide and carbonic acid, like the carbonates, are decomposed when heated to redness with magnesium-filings. The magnesium is oxidised and the carbon is deposited in admixture with the oxide, so that the product resembles lamp-black. The combustion is vivid and highly luminous.

Behaviour of Magnesium with Carbides of Hydrogen.

1. *With Coal-gas.*—Whether or not the coal-gas be washed and dried before

heating with magnesium-filings, a slow combustion takes place, and the product resembles that obtained by heating magnesium in carbonic acid, but with this difference, that it decomposes water slowly, with evolution of fetid hydrogen, while the product formed by heating magnesium with carbonic acid, does not decompose water.

2grs. magnesium-filings, heated to redness in a bulb-ignition tube in a current of coal-gas, unwashed, absorbed 1·67gr. carbon and oxygen.

When 3grs. magnesium-filings were heated to redness in a current of coal-gas, washed by passing it through milk of lime, ferric hydrate, and acetate of lead, and dried with oil of vitriol, the increase of weight by ignition in like manner was only 1·43gr. Marsh-gas was found to have little or no effect on magnesium-filings, hence it would appear that the combustion in these experiments was due to the carbonic oxide; and probably, also, to the benzol present in the coal-gas.

2. *With Marsh-gas.*—This gas generated from a mixture of acetate of soda, quick-lime, and caustic potash, was washed and dried by passing it through oil of vitriol, and, after expelling all the air in the apparatus and tube, 3 grains of magnesium-filings were heated in it, as before, to redness for five or ten minutes, then cooled and weighed. The increase of weight was only 0·03gr.; the filings were merely tarnished, and a little carbon deposited, derived probably from carbonic acid, not absorbed by the lime and potash. Another experiment, also with 3grs. magnesium-filings, heated to a higher temperature for ten or twelve minutes, gave an increase in weight of 0·08gr. The filings were only slightly tarnished as in the first experiment.

3. *With Benzol.*—3grs. magnesium-filings heated in pure benzol-vapour, gave no combustion, but the filings were rendered very brittle, and coloured black, and decomposed water. On dissolving them in dilute hydrochloric acid a separation of carbon took place. The increase of weight was 0·73gr.

Sulphurous acid (SO_2) prepared from copper and sulphuric acid, washed with concentrated sulphuric acid, and passed over magnesium filings heated to redness in a bulb ignition-tube by the gas flame of a good air-burner, gave a vivid luminous combustion. Sulphur condensed on the cool part of the tube, which was expelled by aid of another flame. The current of dry sulphurous acid was passed through the ignition-tube for some time after, withdrawing the flame until the tube was cold, when the product was removed and re-weighed. The combustion of 3grs. magnesium filings (after expelling all the sulphur from the tube) gave a product which weighed 4·86grs., and when treated with nitric acid, evolved fumes of nitrous acid, and gave with chloride of barium a precipitate insoluble in hydrochloric acid, thus showing that the sulphurous acid was not completely reduced.

Before closing this paper it is desirable to draw attention to the erroneous statements on alloys of magnesium which have gone uncontradicted up to the present time. It has been said that magnesium would give a somewhat tenacious and malleable and useful alloy with copper. It is, however, much to be regretted that none of the alloys of magnesium and copper possess the least tenacity or malleability. Magnesium alloys with copper as with most, if not all, metals in different proportions, and the larger the proportion of magnesium the more brittle is the alloy. With copper the colour becomes paler, according to the increased proportion of magnesium.

ON THE OXIDATION OF ETHYLIC AND METHYLIC BENZOATES.

By R. H. Smith, F.C.S.

At the suggestion of Mr. Chapman I was induced to undertake the following investigation:—

Pure ethylic benzoate was digested with excess of a 12 per cent. solution of potassic dichromate and dilute sulphuric acid, at the temperature of 100° C. for nine or ten hours. The tube was then removed from the water-bath and left to stand all night. In the morning beautiful white crystals were observed, and the tube on opening gave little or no carbonic acid, but there was a strong smell of acetic acid. The white crystals thus produced were dissolved in a large quantity of hot water, and a solution of argentic nitrate added. The whole was then heated and set aside to crytallise. After another crytallisation the salt was submitted to analysis.

0·1355grm. of the silver salt was precipitated with hydrochloric acid, and the resulting argentic chloride washed, dried, and ignited. The argentic chloride weighed 0·085grm., whence the percentage of silver is 47·15, agreeing closely with the theoretical percentage of silver in argentic benzoate—

$C_7H_5AgO_2$, which is 47·16.

The liqu a found in the tube was carefully distilled, until it no longer retained sulphuric acid. A portion of this was heated with alcohol and sulphuric acid, when the well-known smell of ethylic acetate was obtained. The remaining portion was then treated with baric carbonate, which dissolved freely; an excess was added and the liquid boiled and filtered. The resulting clear solution was evaporated to dryness in the water-bath, and the residue dried at 110° C.

I. 0·0970grm. o the barium salt was precipitated with dilute sulphuric acid, and the baric sulphate ignited. It weighed 0·0885grm. Percentage of barium, 53·60.

II. 0·1140grm. gave 0.1040grm. of baric sulphate. Percentage of barium, 53·59.

These numbers agree very nearly with the theoretical percentage of barium in baric acetate Ba″ $(C_2H_3O_2)_2$, viz., 53·72.

In one experiment the carbonic acid was determined with the following result:—

1·7990grm. of ethylic benzoate gave 0.0020grm. of carbonic acid. This is only a trace. It is quite possible, therefore, to produce benzoic and acetic acids from ethylic benzoate, without carbonic acid, a result which is in harmony with theory.

$$\left.\begin{matrix}C_7H_5\\C_2H_5\end{matrix}\right\} O_2 + O_2 = \left.\begin{matrix}C_2H_3\\H\end{matrix}\right\} O_2 + \left.\begin{matrix}C_7H_5\\H\end{matrix}\right\} O_2.$$

After having tried the action of potassic dichromate of ethylic benzoate, was induced to try it on the methyl-compound.

Methylic benzoate is decomposed by potassic dichromate in a similar manner. A quantity of this compound (prepared by the distillation of benzoic acid with wood-spirit and sulphuric acid) was introduced into a tube with an 8 % solution of the potassic dichromate, and the tube, after being sealed, was digested in the water-bath for several hours. It was then allowed to cool, when the benzoic acid made its appearance, entirely filling the tube with white crystals. On opening the tube, carbonic acid escaped; the contents of the tube were thrown upon a filter, by which most of the benzoic acid was separated from the liquid. The liquid was then distilled, the distillate converted into barium salt, and the barium determined, which gave a percentage agreeing very closely to that required by formate of barium. The benzoic acid was converted into the silver seat, and the percentage of silver determined, which also agreed with that required by argentic benzoate.

Methylic benzoate is therefore resolved, as might be expected, into benzoic acid, carbonic acid, and more or less formic acid.

It will be seen from the foregoing results that benzoic acid, and probably the acids of the benzoic series, will resist the power of oxidising agents, as well as those of the acetic series, as shown by Messrs. Chapman and Thorp.

These experiments were performed in the laboratory of the East London Soap Works.

ON A NEW SYNTHESIS OF FORMIC ACID.

By Ernest Theophron Chapman.

[*Contribution from the Laboratory of the London Institution.*]

From a careful consideration of the results obtained by Mr. Thorp and myself in our investigation of the action of oxidising agents on organic bodies, it appeared to me difficult to account for many of the reactions, on the assumption that nascent oxygen was the sole agent in effecting the change. Thus, to take a very simple case, acetate of ethyl yields by oxidation two equivalents of acetic acid. In this case we have the same amount of hydrogen in the products obtained as in the substances operated upon. There are only two hypotheses possible in this case; either the ethyl has given up a portion of its hydrogen to the residue of the acetic acid, and has then itself appropriated two equivalents of oxygen, or the acetic ether has been decomposed by the assimilation of water and the substitution of oxygen for hydrogen, which amounts, in point of fact, to the action of hydroxyl. The assumption of the existence of hydroxyl in the oxidising mixtures described in the paper before alluded to is, of course, an impossibility, for hydroxyl is immediately decomposed by these liquids. It is, we know, difficult to convert water into peroxide of hydrogen, but I am at a loss to understand the decomposition of bichromate of potash by concentrated sulphuric acid and heat, unless upon the assumption that hydroxyl is formed and at once decomposed by the excess of chromic acid present. This may appear a somewhat strained hypothesis. In order to give it weight, it was necessary to find some instance in which an unequivocal addition of hydrogen actually took place in such an oxidising mixture. The following synthesis of formic acid furnishes such an instance, and I may remark that it was not undertaken with any idea of proving the truth of the foregoing hypothesis, though, had it not been for that hypothesis, I should in all probability, neither have carried out the investigation, nor have put a correct interpretation on the results obtained.

I wished to know whether an acid solution of permanganate had any action upon carbon in the free state, *i.e.*, charcoal, lampblack, &c. I found that it did act upon it, though but slowly, unless the solution were very concentrated and contained much acid. Still there was no question but that action, and very considerable action, too, took place, provided sufficient time were allowed.

Crystallised permanganate of potash was dissolved in distilled water, and as much sulphuric acid added as would serve to liberate the permanganic acid. Lampblack, which had been intensely ignited, was then added, and the mixture boiled. After some hours' boiling, the solution had changed to a brownish-black colour. On standing it became clear. The colour of the clear liquid was then seen to be very faintly pink. A few drops more sulphuric acid were added, and the mixture distilled. The distillate was tasteless, or nearly so, and quite colourless, but, on adding a drop of ammonia and a little nitrate of silver, and boiling, a brown coloration was obtained. This constitutes the well-known test for formic acid. Now, as even after the most intense ignition, lampblack is said to retain traces of hydrogen—a statement which I am utterly unable to verify—I thought it advisable to employ some form of carbon which should be free from this objection. I tried passing carbonic acid over ignited sodium, but the yield of carbon from this experiment is deplorably small. The mixture of oxide of sodium and carbon was dissolved in distilled water.

[N.B. The distilled water employed in this and all the following experiments had been re-distilled slowly from permanganate. The vessel in which the distillation was conducted, as well as the interior tube of the condenser and every other piece of glass apparatus used, had actually been made red-hot, so that it was free from all suspicion of organic matter. No cork, india-rubber, or any form of organic matter was allowed to touch the interior of any of the vessels.]

The carbon gradually settled to the bottom, the alkaline solution above it was poured off, and the carbon washed by decantation with hot distilled water. It was then operated upon in the manner already described, very minute quantities of permanganate and sulphuric acid being employed. The operation was conducted in a digestion tube in the oil bath. The tube was opened, a little sulphuric acid added, and a small portion of the liquid distilled of, But little

of the carbon had disappeared. The liquid in the tube was poured off, more distilled water added, this again poured off, permanganate of potash and sulphuric acid again added, and the process repeated. This was done six times. The distillate obtained in this manner was rendered alkaline by a drop of solution of potash, evaporated down to a very small bulk, and the silver test for formic acid applied. It gave a very considerable precipitate.

The carbon used in the next experiments was obtained from bisulphide of carbon by the action of sodium. These two substances, when gently heated together, yield sulphide of sodium, and a substance which I take to be pure carbon. It was washed in the manner previously described, and ignited in a covered platinum crucible. There was something more than a gramme of it. It was treated in precisely the same manner as the carbon obtained from carbonic acid had been, and the distillate obtained from it also gave the characteristic reaction with ammonio-nitrate of silver.

Still no quantity of formic acid had been collected. Reactions had been obtained which rendered it highly probable that formic acid was a product of the gradual oxidation of carbon, but the proof was still far from complete. The question in fact resolved itself into this apparently simpler one: where can we obtain pure carbon, not in the graphite state, but in the amorphous condition? I believe that it may be obtained by simply igniting lamp black; but I fear most chemists would regard this as a delusion. I therefore mixed finely divided lamp black with a small quantity of nitrate of potash, insufficient to burn more than half of it. This mixture was heated in a platinum crucible. It deflagrated. A portion of the carbon of course remained unconsumed. This carbon I hope may be regarded as free from organic matter; if not, I despair of finding any. The carbon was washed out of the accompanying potash salts with distilled water and dilute sulphuric acid, and then treated in the manner previously described. By several operations nearly twenty grammes of it were obtained. These were divided amongst five digestion tubes; great care is necessary in these experiments in apportioning the acid to the permanganate. The solution must be perceptibly, but not more than perceptibly, alkaline at the close of the operation. If too much or too little acid is employed, no formic acid whatsoever is produced. This I have repeatedly verified to my cost. It is better that the liquid should be a little too alkaline than too acid. No advantage whatsoever is gained by using large quantities of permanganate. For instance, to four grammes of carbon, two decigrammes of permangate of potash, and a corresponding quantity of sulphuric acid may be added apparently with exactly the same yield of formic acid as if only half the quantity were employed; in fact, three of my tubes were always charged with about twice as much permanganate as the other two. The same number of operations were performed with each lot of carbon, viz., eight, and, as will be seen below, the amount of formic acid obtained from the other two tubes was almost exactly two-thirds of that obtained from the other three.

These operations extended over a considerable time—in fact, I was about six days engaged in charging these tubes and distilling from them. The product of two days' work was employed in obtaining satisfactory qualitative tests with oxide of mercury and ammonio-nitrate of silver. I obtained the reduction of both these substances.

The products of the other four days' work were devoted to analysis. About three-fifths of the total product (less than a decigramme) was employed in making a combustion, that is to say, the barium-salt obtained from the distillate was so employed. The remaining two-fifths, also converted into a barium salt, were employed in determining the saturating capacity of the acid. Combustion was performed with chromate of lead. From the barium determination the following numbers were obtained:—

Substance taken ...... 0·1402 Ba_2SO_4 found ...... 0·1428
Therefore .... 59·89 % Ba.

By combustion the following numbers were obtained:—

Substance taken ...... 0·2052 barium salt.
Found .... 0·0784 CO_2 and 0·0165 H_2O;
Therefore .... 10·44 % C.,
and ·89 % H.

Theory.		$CHBaO_2$.	Found.
C	12	10·57	10·42
H	1	0·88	89
Ba	68·5	60·35	59·89
O_2	32	28·20	—
	113·5	100·00	

It appears therefore beyond all doubt that formic acid may actually be obtained by the action of permanganic acid upon carbon. The process is difficult in the extreme, and little more than traces of the acid are obtained. It is only under the circumstances here specified that it is obtainable. We require free permanganic acid to act upon carbon, but a trace of potash or some alkali, and not more than a trace, must be present. I imagine that a comparatively large quantity of formic acid is formed and destroyed during the process.

ROYAL GEOGRAPHICAL SOCIETY.

The fourteenth and last meeting of the present session of this society was held at Burlington House on Monday evening, the 24th June, Sir R. I. Murchison, Bart., President, in the chair.

The first paper was "On a visit to the Russian Settlements on the Coast of Manchuria," by the Rev. W. V. Lloyd, R.N. The author visited these places as chaplain to H.M.S. *Scylla*, Captain Courtenay, in the summer of 1866, and in his paper described in succession Novogorodoki or Posiette, in Expedition Bay, near the frontier of Korea, Wladivostock or Port May, Nakhodha Bay, and Olga Bay. Expedition Bay is a splendid harbour, affording an impregnable position and a secure shelter for Russian fleets. Being an open harbour during the winter months, its possession is of the greatest advantage to the Russians, the northern harbours on the coast being frozen for several weeks in the year. Since the cession of the country in 1859, Russia has taken complete military possession not only of the coast but of the right bank of the Usuri River, a southern tributary of the Amur, and drafts of regiments or of sailors are established every ten miles, employed in making the great military road which is to connect the settlements with the Amur. Wladivostock, a comparatively flourishing place further north, is only 200 miles distant overland from the head of navigation on the Usuri, and steamers can navigate the river from that point to the Amur, a distance of about 450 miles. The author described the settlements as thinly peopled, and their trade at present of very small amount. The freest information was afforded concerning the country by the Russian officials.

A second paper was "On a communication between India and China by the line of the Burhampooter and the Yang-tze-Kiang," by General Sir Arthur Cotton, R.E. The object of the author was to excite attention to the vast importance of establishing a line of land communication between the navigable portion of the Yang-tze-Kiang and that of the Burhampooter in Assam; thus connecting two vast empires, one of which was peopled by 400,000,000 of inhabitants and the other by 200,000,000. The distance was not more than 250 miles, and this was the only obstacle to a prospective complete system of internal navigation between China and the Indus, by way of the Yellow River, the Grand Canal, the Yang-tze, the Burhampooter, the Ganges, and a canal which will sooner or later be made between the Jumna and the Sutlej. The author stated that he had been unable to find any information with regard to this narrow tract of intervening country which was said to be traversed by inaccessible mountains. No European had visited it; and he concluded his paper by sketching out a plan of exploration by parties ascending the Irawaddy and co-operating with others crossing the ranges from Assam.

In the course of an animated discussion which followed, Sir Arthur Cotton's views were opposed by Sir Arthur Phayre and Dr. M'Cosh, who were of opinion that a more southerly line of communication, *viâ* Bhamo, and the Chinese province of Yunan was much more practicable than the one suggested; it was fair evidence of the impassable nature of the mountains between the eastern frontier of Assam and Sze-Chuen, that no native commercial route existed in that direction, whereas there was a well-known caravan-road between Bhama and China.

General G. Balfour urged the importance of the exploration suggested by Sir Arthur Cotton, which might result in the establishment of a road for the migration of Chinese labourers, skilled in the cultivation of tea, to the fertile valley of Assam, where they were so much required.

Mr. J. Crawfurd objected that the provinces with which India was sought to be connected were the most unproductive portions of China, and the Yang-tze-Kiang of no use for navigation much beyond Hankow.

The Hon. George Campbell looked upon the proposed immigration of Chinese into the Valley of the Burhampooter as the most important point in the paper, and advocated exploration being made with a view to the discovery of a road for light traffic.

The President compared the plans of internal water-navigation suggested in the paper with those carried out in Russia by Peter the Great; but there was this difference between the two countries, that the river basins of Russia were separated by undulating tracts of country of small elevation, whereas in Assam and Western China they were hemmed in by lofty ranges of mountains. He concluded by congratulating the society on the very successful session now terminated.

The following gentlemen were elected fellows of the society:—C. J. Bayley, Esq. (late Governor of the Bahamas); F. A. Goodenough, Esq.; Nathaniel Platt, Esq. (of Rio Janeiro); General Sir Moyle Sherer; and the Hon. Richard Gilbert Talbot.

PRESENTATION OF THE ROYAL AWARDS.

The Founder's Gold Medal is awarded to Admiral Alexis Boutakoff, for being the first to launch and navigate ships in the Sea of Aral, an achievement which led to the establishment of steam navigation on that sea and up the great River Jaxartes, into the heart of Turkestan; also for his subsequent successful survey of the chief mouths of the Oxus, in the Khanat of Khiva. The Patron's Gold Medal to Dr. Isaac I. Hayes, for his memorable expedition in 1860-61 towards the open Polar Sea, wherein he attained a more northern point of land in Smith Sound (81° 35′) than had been reached by any previous navigator.

In presenting the medals the President first spoke as follows: In estimating the advance of geographical knowledge, it is obvious that our allies the Russians have, by their numerous active scientific researches along and beyond their distant frontiers, thrown quite a fresh light upon the physical structure and geography of Central Asia; and in my address of this day I shall dwell upon points relating to this subject which I have not touched upon at former anniversaries.

It is now my pleasing duty to announce that our council has selected one of these explorers, that enterprising naval officer, Admiral Alexis Boutakoff, who in the year 1852 transmitted to us a modest account of his survey of the Sea of Aral, as the recipient of our Founder's Medal. That inland sea, though unknown to the ancients, was distinctly recognised by the Arabian geographers, from the year 600, as the Sea of Kwarezm. In the middle and dark ages all knowledge of it was lost to the western world, and it was not until Russia, desirous of an accurate exploration of her Asiatic frontiers, sent, in 1825, an expedition to examine its shores, under General de Berg, that any real acquaintance with its condition was obtained.

It was only, however, when ships built at Orenburg were transported in pieces across the wild steppes, that Captain Alexis Boutakoff launched the first flotilla on that sea, and after two years of navigation ascertained its outlines and depth, and the nature of the large islands within it.

On a recent occasion Admiral Boutakoff has also laid before us a sketch of his able examination of the mouths of the Oxus, where that river empties itself into this inland sea.

Again, it is still more important to dwell upon the other great services he has rendered to his country and the civilised world, in having proved that the Jaxartes of the ancients (the Syr Daria of the Asiatics), which flows into the Sea of Aral, is a stream which steam-vessels can navigate for upwards of 500 miles above its mouth.

It was by this discovery that a safe line of communication between Europe and China, through Western Turkestan, was first laid open to Europe; so that whilst Britain has had and holds her own high road to India and China by the ocean, Russia, after trading overland for centuries with Western China under great difficulties, owing to the intervention of barbarous and hostile tribes, has at length opened out for herself a course along which, by the interposition of small protective forts, she will have a safe trade through Turkestan with the Celestial Empire.

Admiring as I do the great progress made by Russians in advancing our knowledge of the geography of Central Asia, I have a peculiar satisfaction in knowing that our Founder's Medal has been decreed to one who is so good a type of those enlightened explorers.

Turning to the Russian officer appointed to receive the medal, the President continued: Though unable to be present himself, I rejoice that his place is taken on this occasion by a distinguished brother officer of the Imperial Russian Navy; and I therefore request you, Captain Crown, to convey this medal to Admiral Alexis Boutakoff, as the expression of our admiration of his deeds.

Captain Crown thus replied: Mr. President,—I beg to return thanks to the Royal Geographical Society on behalf of Admiral Boutakoff, for the honour they have conferred on him by awarding him this Founder's Medal. Being myself a member of the Imperial Russian Navy, I cannot but feel proud at having been called upon by you, Mr. President, to perform the pleasant duty of receiving from your hands this evidence of the high appreciation of Admiral Boutakoff's labours by the Royal Geographical Society, in a region which, even at the present time, is so very little known to the scientific world. The kind approval which Admiral Boutakoff's works have met at the hands of an institution so widely known and esteemed in Russia, and of which you are, Sir, the honoured president, will undoubtedly be a source of mutual advantage in the cause of science, and will encourage our Russian geographers to seek a closer acquaintance with your Society, by offering their works in a version more accessible to English scientific readers than the Russian language, so that you will be better able to follow and judge of the progress of geographical researches in Russia, as carried on by your sister institution in St. Petersburgh; at the head of which, as you are well aware, is his Imperial Highness the Grand Duke Constantine. I shall lose no time in forwarding to Admiral Boutakoff this medal, and I only regret that I cannot express his thanks to the Royal Geographical Society, and to you, Sir, in so admirable a manner as he would have done himself, if he were here.

The President next addressed the Hon. C. F. Adams, Minister of the United States, in the following words:—

Mr. Adams,—Eleven years have elapsed since the Royal Geographical Society did honour to itself by awarding a gold medal to your highly distinguished countryman the late Dr. Kane, for his discoveries in the Polar regions, while in charge of an expedition generously fitted out in the United States to search for Sir John Franklin; and now I rejoice to say that I have to ask you, as the representative of the great American Republic, to receive the medal of our patron, Queen Victoria, which has been decreed to another of your countrymen, Dr. Hayes, for having reached a more northern point of Arctic land (81° 35′) than ever was attained by any previous explorer.

Forming one of the previous expedition of the lamented Kane, who justly received the applause not only of your country but of the civilised world, Dr. Hayes was on that occasion the discoverer of a large mass of land forming the extreme western shore of Smith Sound, to which the name of Henry Grinnell, an enlightened citizen of New York, the mainspring of that expedition, was most appropriately attached. It is for carrying personal observations to a degree and a half further northward on land than on the previous occasion, and for having sighted the open Polar Sea from the western shore of Kenney's strait, just as Kane's companion Morton had done from the eastern or Greenland shore of the same, that our council has most deservedly adjudicated to him our patron's medal.

The scientific results of this expedition have been to a great extent made known in America, and the Smithsonian Institution has undertaken the publication of those important additions to our acquaintance with the natural history, terrestrial magnetism, and meteorology, as well as the geography of the Arctic regions.

In the meantime the unpretending volume of our medallist, entitled the "Open Polar Sea," is written in so clear, manly, and attractive a style, as must render it very popular among all readers in the British Isles and America.

Just as we know that our old Baffin first discovered and navigated in a very small craft the great bay separating Greenland from America, with which his name has ever since been connected, so the extremest point where these waters lead into what was called the "Open Polar Sea" has been reached by the small American schooner of Dr. Hayes, bearing the name of the "United States."

In perusing the narrative of the hair-breadth escapes of this little vessel when beset by huge floating icebergs, the skill with which she was managed, the stern resolution and ability with which every difficulty by sea or by land was overcome, and the rich scientific fruits which were brought back, with the loss only of the able Mr. Sontag, who made most of the astronomical observations, I may well congratulate your Excellency on the success of a voyage which will ever be remembered among the many great exploits of your countrymen.

I have now only to request you to convey this Victoria medal to Dr. Hayes, with the request that he will accept it as the strongest proof we can offer of our just appreciation of his great merits.

Mr. Adams replied:—Mr. President.—It gives me great pleasure to be the medium of presenting to Dr. Hayes the honourable memorial which your society has voted to him for his services in the cause of science. It is no part of my province to undertake to vaunt any of my countrymen; but I will say that, in no part of the world will you find more people who watch with greater attention and admiration the brave enterprises for public objects which are undertaken in any part of the world. More especially by their natural connection, in all the essential elements of civilisation, with this community, their attention is closely drawn to every movement which takes place here; and following the admiration with which they see what has been done, there grows a desire to emulate the same themselves. It has been often objected to enterprises of this kind, that they can lead to nothing—that they are, in their nature, simply adventures in quest of things that are impossible. But, Mr. President, the same remark might have been made when Columbus first undertook his voyage to the West—to what, he did not know. He thought he might come out somewhere in far Cathay; but the result was, as often happens in life, an unexpected one—and the unexpected turns out to be of greater proportions than anything which had been anticipated. Thus it was that America was discovered, and the influence of that discovery upon the fortunes of the world remains yet to be fully measured. And so it has been with most of the adventures that have been started from the Old World for the discovery of that which was unknown. Very often the explorers do not arrive at what was anticipated; but they attain to a great deal which was not expected, and which has at the same time proved of very great value. And more than that, and greater than all, this pursuit has led to the cultivation and development of high moral qualities in a class of men, who become themselves greater heroes and greater benefactors to the interests of the world than most conquerors who have been lauded in the pages of history. I therefore, Mr. President, accept this medal with great pleasure, and I have no doubt that this marked testimony to the merits of one individual will be felt not only by him, but by all who, at their own cost and expense, carried on his enterprise. It will, moreover, stimulate them to repeat such efforts in emulation of your countrymen, by which the bounds of science may still further be indefinitely extended.

INSTITUTION OF CIVIL ENGINEERS.

The Council of the Institution of Civil Engineers have awarded the following premiums for Papers read at the meetings during the past session:—

1. A Telford medal and a Telford premium, in books, to James T. Chance, M.A., Assoc. Inst. C.E. for his paper "On Optical Apparatus used in Lighthouses."

2. A Telford medal and a Telford premium, in books, to Edward Byrne, M. Inst. C.E., for his paper "Experiments on the Removal of Organic and Inorganic Substances in Water."

3. A Telford medal to George Biddell Airy, Astronomer Royal, Hon. M. Inst. C.E., for his paper "On the Use of the Suspension Bridge with Stiffened Roadway for Railway and other Bridges of Great Span."

*4. A Watt medal to Colonel Sir William Thomas Denison, K.C.B., R.E., Assoc. Inst. C.E., for his paper on "The Suez Canal."

5. A Watt medal, and a Telford premium, in books, to John Bourne, for his paper on "Ships of War."

*6. A Telford premium, in books, to Capt. Henry Whatley Tyler, Assoc. Inst. C.E., for his Paper "On the Working of Steep Gradients and Sharp Curves on Railways."

*7. A Telford premium, in books, to William Henry Preece, Assoc. Inst. C.E., for his paper "On the Best Means of Communicating between the Passengers, Guards, and Drivers of Trains in Motion."

*8. A Telford premium, in books, to William Alexander Brooks, M. Inst. C.E., for his paper on "The River Tyne."

9. The Manby premium, in books, to Charles Douglas Fox, M. Inst. C.E., for his paper "On Light Railways in Norway, India, and Queensland."

The council of the Institution of Civil Engineers having for some time past observed a growing desire of the junior members of the civil engineering profession to be present at, and take a part in, the discussion of many interesting papers that have been read and discussed in the theatre of the Institution, determine to adopt some course by which the usefulness of the Institution might be extended. The result has been that at a general meeting of members held on the 26th June, various alterations in the bye-laws were made, and the following circular has been issued under date July 16:—

"Dear Sir,—I am instructed to forward a copy of the bye-laws and regulations of the Institution of Civil Engineers as amended and enlarged at a general meeting of members held here, pursuant to notice, on Wednesday, the 26th day of June last; and I am particularly to direct your attention to Section IV., respecting the admission of students.

"With a view of increasing the usefulness of the institution, particularly to the junior members of the profession, it has been decided, you will observe, to create a student class, to take very much the place of that which was formerly the graduate class, but with certain modifications, so as to avoid the difficulties which previously arose, and to provide those advantages which experience has pointed out to be desirable.

* Have previously received Telford medals.

"Although not specifically mentioned in the rules, it is contemplated to grant, under the control of the Council, the use of the theatre of the institution to the students, for supplemental meetings, for the reading and discussion of papers among themselves, and possibly, also, for the delivery to them of lectures upon special subjects; the object of such supplemental meetings being for the advancement in scientific and technical knowledge of the junior members.

"Believing it to be of the highest importance that the profession should not be divided, but should remain one united body, having a position and an influence which one united body only can have, the Council trust that you will cordially unite with them in the endeavour so to extend and enlarge the basis of the institution, as that it shall continue to embrace within it all branches of engineering and all classes of engineers.

"In case you may know any gentlemen wishing to avail themselves of the privileges of the institution and of these new arrangements, I have been directed to send to you, one copy of the form of proposal for ordinary candidates desirous of joining the institution, and two copies of the form of application for the admission of students.

"I am, dear Sir, yours faithfully,
"JAMES FORREST, Secretary."

Extracts from the Bye-laws.
Section II. Constitution.

1. The Institution of Civil Engineers shall consist of three classes, viz., members, associates, and honorary members, with a class of students attached.

2. Members.—Every candidate for admission into the class of members, or for transfer into that class, shall come within the following conditions:—

He shall be more than twenty-five years of age, shall have been regularly educated as a civil engineer according to the usual routine of pupilage, and have had subsequent employment for at least five years in responsible situations as resident engineer, or otherwise, in some of the branches defined by the charter as constituting the profession of a civil engineer; or,

He shall have practised on his own account in the profession of a civil engineer for at least five years, and have acquired a considerable degree of eminence in the same.

3. Associates shall be persons of more than twenty-five years of age, who are not necessarily civil engineers by profession, but whose pursuits constitute branches of engineering, or who are by their connection with science or the arts qualified to concur with civil engineers in the advancement of professional knowledge.

4. Honorary members shall be either distinguished individuals, who from their position are enabled to render assistance in the prosecution of public works, or persons eminent for science and experience, in pursuits connected with the profession of a civil engineer, but who are not engaged in the practice of that profession in Great Britain or Ireland.

5. Students shall be persons not under eighteen years of age, who are, or have been, pupils of members or associates of the institution, and who have the object or intention of becoming civil engineers; and such persons may continue students until they attain the age of twenty-six years, but not longer.

Section IV. Admission of Students.

1. Students may be admitted by the Council on the recommendation (according to form A 2 in the Appendix) of the member or associate under whom they are, or have been, pupils; and they may remain students of the institution, at and during the pleasure of the Council, until they attain the age of twenty-six years, when they shall cease to be students.

2. Any person admitted into the institution as a student shall be informed thereof by a letter (according to the form E 1 in the Appendix), stating that the first year's subscription must be paid within two months, otherwise the admission will be void, when he shall be entitled to attend the ordinary general meetings, but not to vote at such meetings, and to have the use of the library, but subject to such regulations as the Council may, from time to time, prescribe, as well as to receive a copy of the minutes of proceedings relating to each session during which he shall continue to be a student.

3. Students of the institution are eligible to compete for the premiums or prizes arising out of the "Miller Fund," and any other funds appropriated by the institution, or any person or persons, for premiums or prizes for students.

4. The Council may accord to students other privileges, but subject to such terms, regulations, and restrictions, as they shall from time to time prescribe.

5. No student will be allowed to introduce a stranger into the rooms of the institution.

Fees on Election.	£	s.	d.	Annual Subscription.	£	s.	d.
Admission Fee—				Non-resident Student ...	1	11	6
Associate	3	3	0	Resident Student ...	2	2	0
Member	3	3	0	Non-resident Associate...	2	12	6
Building Fund—				Resident Associate...	3	3	0
Associate	4	4	0	Non-resident Member ...	3	3	0
Member	7	7	0	Resident Member ...	4	4	0

The form A 2, for the proposition of students, may be had on application.

NOTES OF SHIPBUILDING AND MARINE ENGINEERING ON THE CLYDE.

The total number of vessels launched on the Clyde during the month of May, was 13; of these 8 were steam vessels, and 5 sailing vessels. 7 out of the 8 steamers—all built of iron—were screws; 3 of the sailing ships were built of iron, one (the *Trochrague*, of 700 tons) of wood, and one (a cutter yacht of 175), composite. The whole—excluding the tonnage of a small screw cargo barge included in the above list—representing a total tonnage of 9,167.

Amongst the launches on the Clyde during the month of June, we may mention the following:

Launch of the "Pelican" at Govan.

Messrs. Randolph, Elder, and Co., launched from their shipbuilding yard at Fairfield, Govan, the *Pelican*, a screw steamer of 109 tons, builder's measurement, and 30 horse-power (nominal), of the following dimensions:—Length over all, 90ft.; breadth, 16ft.; and depth (moulded), 9ft. The *Pelican* has been built to the order of the Ocean Fishery Company, Bordeaux, and is intended for deep-sea fishing off the French coast. Her engines, which are being supplied by the same firm, are upon their patent double cylinder expansion principle, fitted with surface condensers and superheaters, are similar to those of the *Cormoran* and *Heron*, built for the same company last year, by Messrs. Randolph, Elder, and Co. We may here add that from enquiries made of us by correspondents, an opinion prevails in some quarters that Messrs. Randolph, Elder, and Co. have only recently adapted their patent double cylinder engines to the propulsion of screw steamers; this is not so, and we refer our readers to The Artizan vols. for 1860-61, in which full particulars will be found, illustrated by engravings, of the sister screw steam ships, the *San Carlos* and the *Guayaquil*, and their inverted double cylinder expansion engines. Messrs. Randolph, Elder, and Co. have, during the last years, fitted a large number of screw steamers with this class of engines, and they are all giving general satisfaction to their owners.

Launch of the "Miami," at Govan.

Messrs. Dobie and Co. launched from their building-yard, Govan, an iron sailing barque of 541 tons, named the *Miami*, built for Messrs. Donaldson Bros., Glasgow.

Launch of the "Corsair," at Port-Glasgow.

Messrs. Henry Murray and Co. launched from their building-yard, at Port-Glasgow, a smart little screw-steamer, of 100 tons, named the *Corsair*. She has been built to the order of Mr. John Macfarlane, and is intended to run in the West Highland trade, in consort with the *Norseman*. The Messrs. Murray are a young but enterprising firm. The *Corsair* is the third vessel which they have launched.

Launch of the "Reichstag," at Kelvinhaugh.

Messrs. A Stephen and Sons launched from their works, at Kelvinhaugh, a fine new iron sailing ship, of 750 tons, A 1 at Lloyd's, and the highest class in the register *veritas*. This vessel, named the *Reichstag*, is the fourth ship built by Messrs. Stephen for her owner, R. M. Sloman, Esq., Hamburg, one of the representatives of that city in the North German Parliament, and is to be employed in the Hamburg and New York trade.

Launch of the "Palermo," at Maryhill.

Messrs. J. and R. Swan, Kelvin Dock, Maryhill, launched a fine three-masted screw-steamer, named the *Palermo*, of 400 tons burden. She has been built for Messrs Morris, Munro, and Co., Glasgow, and is intended for the Mediterranean trade.

Launch of the "Carnarvon Castle," at Whiteinch.

Messrs. Barclay, Curle, and Co., launched from their yard, Whiteinch, a clipper-ship, the *Carnarvon Castle*, of 1,200 tons register, for Messrs. D. Currie and Co.'s line of "Castle" packets between Calcutta and London and Liverpool. The principal dimensions of the vessel are:—Length, 220ft.; breadth of beam, 36ft.; and depth in hold, 22ft.

Launch of the "James Aiken" at Port Glasgow.

Messrs. John Reid and Co. launched on the 3rd ult. a fine iron sailing ship of 960 tons register, and 1,050 tons burden, named the *James Aiken*, after the eminent merchant of that name in Liverpool; she is owned by Messrs. McDiarmid, Greenshields and Co., of that city, and is intended for the Calcutta trade.

Launch of the "Jaguarete" at Pointhouse.

A fine twin screw steamer, named *Jaguarete*, was launched on the 18th ult. from the building yard of Messrs. A. and J. Inglis, for Messrs. Isaac and Samuel, of London. The *Jaguarete* is 145 feet long, 24 feet in breadth, and 8 feet depth of hold, and will be fitted by her builders with two pairs of direct acting condensing engines of 25 H. P. nominal each; she is, we understand, to be employed in the South American trade.

Launch of the "South of Ireland" at Renfrew.

This vessel, a fine iron-paddle steamer of 600 tons, built and engined by Messrs. W. Simons and Co., was launched on the 6th ult. from the

the London Works, Renfrew. She is fitted with oscillating engines of 200 H. P., and is intended to run in concert with the steamer *Great Western*, recently built by the same firm, on the Milford and Waterford Stations, where the Channel service is conducted in connection with the Great Western Railway.

Launch of the "Spendthrift" at Overnewton.

Messrs. Charles Connell and Co. launched on the 18th ult. from their west shipbuilding yard, at Overnewton, a handsome composite clipper sailing ship, named the *Spendthrift*, of 1,350 tons burden, classed 14 years A 1 at Lloyd's. This vessel has been built expressly for the China tea trade, and is to be commanded by Captain Innes, who is well known in that trade, and is expected to take part in the annual ocean race home from China with the new teas next year.

Launch of a Screw Yacht at Greenock.

Messrs. Robertson and Co. launched on the 18th ult. a smart screw yacht for employment on the river Plate, as a tender to ships, and will shortly be conveyed to her destination. She is 55 feet long, 10½ feet beam, and 6½ feet depth, and is fitted with geared twin engines by Mr. D. Rowan of Glasgow.

Launch of the "Garrison" at Whiteinch.

Messrs. Aitkin and Mansel launched from their shipbuilding yard, Whiteinch, a fine screw steamer, named the *Garrison*, of 800 tons burden. Her principal dimensions are—length of keel and fore rake, 206 feet; breadth moulded, 28½ feet; depth of hold, 16½ feet. She has, we understand, been built through the agency of Mr. John Wilson, consulting engineer, Glasgow, for Mr. W. Laing, Edinburgh, and Mr. A. M. Davidson, Dundee, and will be fitted with direct-acting engines of 100 H. P., by Messrs. James Aitkin and Co., Cranstonhill, Glasgow.

Amongst the launches on the Clyde during the month of July, may be mentioned the following:—

Launch of the "City of Delhi."

Messrs. Barclay, Curle, and Co. launched on the 1st ult., from their Stobcross Yard, a fine iron sailing ship of 1,200 tons register, named the *City of Delhi*, for Messrs. G. Smith and Sons. She is intended for the Calcutta trade.

Launch of the "Hannah Simons," at Kelvinhaugh.

Messrs. Alex. Stephen and Sons, launched on the 3rd ult. a finely proportioned iron screw steamer of 1,000 tons, named the *Hannah Simons*, built for Benjamin Simons, Esq., and is intended, we understand, for the fruit trade under the agency of Messrs. Wilson, Bros. She is at present fitting out, and is berthed alongside the quay on south side.

Clyde-built Yachts.

The iron screw-yacht *Sea Horse*, 300 tons, and 60 horse-power, recently launched from the yard of Messrs. Tod and Magregor, Partick, for the Earl of Cardigan, K.C.B., passed down the river, and proceeded to Gareloch to have her compasses adjusted. Her beautiful model and graceful appearance attracted much attention. It is worthy of remark that two noble English earls belonging to the Royal Yacht Squadron should have had vessels built on the Clyde this year, viz., the *Sea Horse*, and the beautiful schooner-yacht *Nyanza*, launched the other day from the building-yard of Messrs. Robert Steele and Co., Greenock, for the Right Hon. the Earl of Wilton, Commodore of the Royal Yacht Squadron.

We learn from "Hunt's Universal Yachting List" that last year the Clyde-built yachts again represent the greatest earnings in their several classes. The celebrated Clyde-built cutter *Fiona*, belonging to Mr. E. Boutcher, Glasgow, has won the greatest number of money prizes last year of any yacht afloat, her total earnings being £600, represented by seven competitions. The schooner *Selene*, built by Messrs. Steele and Co., Greenock, and owned by Mr. D. Richardson, gained £196 10s. The Clyde-built yacht *Torch*, which formerly belonged to Dr. Finlay, Helensburgh, won five races, the money value of which was £112. The celebrated yacht *Mosquito*, belonging to Mr. T. Holdsworth, Glasgow, carried off two prizes, valued at £200. The *Armada*, lately the property of Mr. B. B. Bell, Glasgow, gained three races, the value of which was £37. The *Madcap*, now owned by Mr. D. Tod, Glasgow, carried off one prize valued at £80. The celebrated cutters *Vindex* gained £231; *Sphinx*, £230; *Pantomime*, £175; *Niobe*, £123 10s.; *Glance*, £130; *Echo*, £165; *Christabel*, £240; while the schooner *Aline* gained £175, and the new yawl *Leah* £220. It is satisfactory to know that Fyfe's *Fiona* gained the greatest number of races and the largest amount of money last year. During the preceding year the *Fiona* won six matches, with prizes amounting to £440; consequently, in two years this celebrated craft has earned no less a sum than £1,040. During 1865 the *Mosquito* won £428, which makes her total earnings in two years £628; while, during the two past years, the 16 ton cutter *Torch*, built by Fyfe, has gained £268.

The Glasgow and Dublin Steam Packet Company.

This company have, we understand, purchased the paddle-steamer *Great Northern*, lately employed on the Dublin and Liverpool Station, and to be placed on the Glasgow and Dublin line, in lieu of the ill-fated *Earl of Dublin*, whose loss we recorded in our last.

The Cunard Steamer the "Russia."

The *Russia*, a notice of the launch of which, on the 20th March last, appeared in our issue of the 1st April, had her Admiralty trial on the 28th May, when she steamed out from Wemyss Bay to Lochranza, and back, sailing steadily and smoothly, and making about fifteen knots an hour, with loading down to Admiralty trial. After the company who were on board on the occasion of the trial trip had been taken off, and landed at the Wemyss Bay Pier, the *Russia* proceeded on to Liverpool, and excited general admiration, on account of her great size and remarkably fine proportions. She sailed from Liverpool on the 15th June on her first voyage to New York, when, besides the royal mails, she took out a valuable cargo and seventy passengers. We may add, to the particulars given in our April number, that provision has been made in the internal arrangements of the *Russia* to allow of her carrying, when required, 1,200 troops, as the vessels of the Cunard line are sometimes brought into requisition as troop ships.

The *Russia* arrived on her first homeward voyage at Queenstown, at 9·30 p.m. on the 18th July, having made the passage under eight days thus fulfilling the anticipations that have been formed as to her proving a rapid sailer, and admirably adapted for the service for which she has been built. Hitherto the fastest and finest vessel of the respective fleets of the three Liverpool transatlantic companies has been considered to be the *Scotia*, of the Cunard line; but the *Russia*, from the rapid run she has made, bids fair to stand first amongst the rapid sailers of the three competing companies. On the run to Liverpool, from New York to Queenstown, there is only a difference of fifty-five minutes in favour of the *Scotia's* fastest run as compared with that of the *Russia*, while on the whole run to Liverpool, the trial is almost the same for the two vessels.

The Clyde Steamer "Mary Helen."

This paddle steamer, lately built by Messrs. T. Wingate and Co., Whiteinch, went down the river on the 3rd ult., with an official inspector on board, for the purpose of testing her speed preparatory to going on a foreign station, when she ran the measured distance between the clock and Cumbrae lights in forty-five minutes, or at the rate of twenty-one miles per hour.

The Paddle Steamer "Rio Uruguay."

This steam ship, just completed by Messrs. Caird and Co., Greenock, to the order of David Bruce, Esq., is 240 feet (say 240) long, 25 feet beam, and 9 feet 6 inches depth of hold, fitted with deck house, extending nearly the whole length of deck; this house is fitted in the fore end with dining saloon for first-class passengers, and abaft the engines with separate cabins for ladies and gentlemen; the after body of vessel is also fitted with first-class passenger accommodation, and the fore body with second-class berths. She is to be propelled with fixed cylinder diagonal engines of great simplicity of construction; cylinders 50 inches diameter; stroke, 5 feet; valves worked by link motion, and fitted with expansion gear, feathering wheels, &c.; steam supplied by 2 boilers, one before and one abaft engines. On trial the engines made with ease 46 and 47 revolutions, with a pressure of 30 lbs. per inch on boilers.

The *Rio Uruguay* is the second saloon steamer Messrs. Caird and Co. have built for Mr. Bruce for service in South America.

OCEAN STEAMERS.

Our experience here grows apace, for our steamers are at work on every navigable water on the face of the globe. Wherever they are we may plainly see the anxiety for economy of fuel in their management. To accomplish this we often find the energies of the engineer on duty severely taxed, even with engines and boilers of our best makers, when within the tropics. The stokers are indolent natives, using colonial coal of an inferior quality, and the water is charged with saline matters in a greater degree than the sea-water of our own coasts. This imposes a more frequent "blowing-off," so that we have but just fed up the boilers to the proper level when the salinometer admonishes us to blow off again, or we are exposed to the dreaded consequences of salting and burning the boilers. A "watch" under such circumstances, and in that temperature, is indeed an arduous task. It would be well to bear these things in remembrance by the makers of engines intended to operate in such latitudes; not altogether in sympathy with the engineers of these vessels, but also in the interest of their own reputation, in relation to this great desire for the economy of expensive fuel. The difficulty can be met, in a great measure, by giving more boiler room than obtains in our own latitudes, and the cost of such boilers can be regulated accordingly. The difference of cost would most likely be covered by the economy of fuel, in two or three long trips.

LONDON WATER SUPPLY.

There are many who are become positively restless in these times of commercial torpidity, and failing in excitement in other directions, it is to be regretted that they employ themselves in practising on the fears of the Londoner, and in tormenting the engineers of the waterworks which supply London with water. The analyst, with his formidable array of figures, only augments the misery of the uninitiated. There it is clearly demonstrated that in one gallon of the water he found no less than ·00012 of a grain of lime. Somebody now jumps to the conclusion that his inside has received sundry coats of whitewash, that he is a sort of peripatetic sepulchre—a whited one.

It would be but considerate to point out the real source of many of those sicknesses which are so recklessly laid at the doors of the waterworks. That source is the consumers own tank, or receiver. Be this receiver constructed of whatever material it may, it will become "foul" in time. Neglect increases that foulness, and its fatal consequences follow as a matter of course.

The remedy lays in the consumers power to apply a periodical cleansing of the tank, or receiver. It were idle to cavil at the degree of purification of the water brought to us, when we leave that water to be contaminated in filthy, poison-charged tanks or water-butts, before we use it. We are cautioned about choleraic symptoms; assuredly we may not invite them by this neglect.

REVIEWS AND NOTICES OF NEW BOOKS.

A Handbook of Practical Telegraphy. By R. S. Culley. Second edition. London: Longman and Co. 1867.

The fact of the first edition of Mr. Culley's book having in a short time been sold off tells more of the estimation in which it is held by those interested in the subject of practical telegraphy than any mere expression of opinion on our part as to the merits of the book as a work of reference on which point, however, we have not failed to acknowledge the claims of Mr. Culley as an author to be recommended as a competent authority and an able compiler of useful information upon this interesting branch of practical science, and we hail with considerable satisfaction the second edition of his handy book. As the work was originally designed chiefly as a guide or handbook for the members or staff of the telegraph service, and treated of—the electrical laws upon which the working of the telegraph system depends for its efficiency; of the methods of discovering faults in the lines or circuit lines, or means of communication; of the practical management of apparatus; of the construction of a line; and of the leading principles of submarine telegraphy, Mr. Culley handled the various branches of his subject in a very plain, intelligible, and practical manner, avoiding all unnecessary technicalities, and succeeded, as we think, very thoroughly in what he undertook to do. In this second edition he has re-written several portions of the work, and has added much that now possesses greater interest, and particularly the subject of submarine telegraphy.

The subjects contained in the body of the work are divided into ten parts, with four hundred and sixty-four sub-divisions, and the appendix and notes, containing all that is new or most recent in the way of discovery or experiment, occupy about forty pages, and much valuable tabulated matter relating to submarine telegraph cables and other *matériel* employed in submarine and land lines.

Perhaps, with one or two exceptions, every description of telegraphic signalling and message-recording instrument hitherto used in this country is described. There is one instrument, however, of which we do not perceive any mention, and which has recently been worked with considerable success on one of the London District Telegraph Company's lines, viz., Warren Thompson's "typo-printer," but it is possible that Mr. Culley does not entertain a sufficiently favourable opinion of that instrument to think it worthy of mention.

The book is very nicely illustrated, and is evidently got up with great care, and we predict for the present edition quite as rapid a sale as that attained by the first issue.

Low's Hand-Book to the Charities of London. London: Sampson, Low, and Co., Ludgate-hill. 1867.

A very useful little hand-book, comprising, as the compiler states on the title-page, "the objects, date, address, income, and expenditure, treasurer, and secretary, of above eight hundred charitable institutions and friends."

The sums annually expended in charity amongst the various charitable institutions of this country are, in the aggregate, so enormous that nothing short of such an accurate and reliable work as that compiled by so excellent an authority as Mr. S. Low, jun., will serve to convince a foreigner of the truth of the statements relating thereto. To the charitably disposed, and in this country "their name is legion," Mr. Low's book will prove a useful aid and reliable guide, and by its use materially assist in preventing frauds, by the unscrupulous and professional impostors, on the unwary amongst the charitable.

Handbook of all Stations, Sidings, Collieries, &c., upon the Railways of the United Kingdom, showing their exact position and the counties in which they are situated. By Henry Oliver and John Bockett, of the Railway Clearing House, London. New edition. London and elsewhere: McCorquordale and Co.; Smith and Ebbs, Postern-row, Tower-hill, E.C., &c. 1867.

Everyone acquainted with the wonderful machinery employed at the establishment at the Railway Clearing House at Enston-square, and the extraordinary amount of labour employed in unweaving the complications which arise out of the interchange of traffic, and the use or employment of foreign rolling-stock and vehicles in transit upon the railways of Great Britain, is surprised at the rapidity and accuracy with which that now monstrous business is conducted by the staff employed upon that establishment.

The system and regular order to which the current business of the Railway Clearing House has been reduced by the heads of departments, has shown to others connected with the railways, the necessity for introducing various aids for the better and more expeditious conduct of the out-door business, more particularly of goods forwarding, and whilst our railway system has been extended with giant strides, new lines, new stations, new junctions, and new everything in connection with railway development have been created and christened by names most conflicting, confounding, and often inconveniently similar, or identical with those in other places in a totally opposite or different part of the country. Our knowledge of local geography, and more particularly chorography and topography, has been unable to keep pace therewith, and the perplexity of the unlearned in such matters incident to there being several railway stations of the same name in different counties, may be well understood when, on turning to the first list of stations under letter A only of the alphabetical classification to be found in the Hand Book of Messrs. Oliver and Bockett, we discover one Abingdon and two Abington stations, each in a different county and on a different railway line; also two Actons, two Adlington, two Alresford, two Appleby, two Ascot or Ascott, two Ashford, and two Ashwell stations, besides other identical names having only an addition, such as "Ambergate-station," Derbyshire, on the Midland, and "Ambergate-yard" station, Lincolnshire, on the Great Northern. We could multiply instances out of number by going through the lists of stations under the various headings distinguished by the several alphabetical letters. These, however, will be sufficient to show the necessity for such a "hand book" as that now under notice; and too much praise cannot be bestowed upon the officials at the Railway Clearing House, for the laudable anxiety they have shown, to afford the public every kind of useful information upon subjects that came daily under their personal observation, and to facilitate the multifarious transactions incident to and connected with the passenger and goods traffic, as well as the use and interchange of rolling stock and moveable plant on the railways of Great Britain, and amongst those clearing house officials Messrs. Oliver and Bockett are distinguished for, amongst other things, their useful publication, the "Hand Book of the Stations, Sidings, &c." The qualities of comprehensive usefulness and perspicuity which belong specially to this book, and its cheapness should insure its being in the hands of everyone interested in the transport of goods, and railway transit generally.

Railway Junction Diagrams. By John Airey, of the Railway Clearing House, Euston Square, London, and published by him at the Railway Clearing House.

With the enormous extension of the railway system, which has taken place throughout Great Britain, more particularly during the last fifteen years, and the complication of junctions necessitated by the combined operations of railway companies formerly rivals, which the Legislature has been the means of enforcing, the necessity for a thoroughly well organised and systematic working of junctions, by means of mechanical contrivances effecting certainty of action, was evidently of prime importance;—at least from an engineering point of view;—and, for the public safety, it was evidently the chiefest requirement, as was felt and admitted by every experienced traffic manager in this country,

The accomplishment of the problem of how best to effect these very desirable objects has now, it appears to us, been very satisfactorily solved, and the most complicated and difficult to be worked junctions may now, if railway directors and managers so will it, be managed with perfect safety and security to life and property.

The knowledge of the past difficulties in the way of realising this great result must have been in the minds of the many, and the mode of overcoming in the mental grasp of the very few, and these too of no ordinary or mean order of mechanical skill, combined with a thorough knowledge of

traffic management; for on taking up Mr. Airey's very interesting book of "Railway Junction Diagrams," and examining the enormous number of complicated junctions which exist in Great Britain. and which have to be worked daily, some of them with upwards of 800 trains passing through during the twenty-four hours (as is frequently the case at the Clapham Junction), this must be thoroughly apparent.

For the first time, then, in the history of railways, the general arrangement, character, and extent of the various railway junctions throughout Great Britain have been carefully and systematically drawn, reduced, and collected in the book of plans published by Mr. Airey, under the title of "Railway Junction Diagrams."

These, as the compiler informs us, show the connecting points between all the railways in Great Britain, also the distances in miles and chains between the several points at each junction, the running powers, and special allowances under Act of Parliament, prepared from official drawings, and corrected by the companies.

Mr. Airey has on the various plans shown the actual points of junction where traffic can be exchanged, which are denoted by a small circle, and by having the word "junction" also inserted. Where lines intersect each other on the diagram, and no circle or word "junction" appears, it may be taken for granted that the lines are on different levels, and that no exchange of traffic can be made.

The diagrams are not in alphabetical order, but an index has been made for facility of reference. Space has also been left at the end of the book for new diagrams, which will be published at a small cost, from time to time, as new junctions are opened.

Where there are several companies working into and out of the same junction, different colours are employed to denote them, and the lines and junction pieces in process are shown in dotted lines, and, as in the case of the Bedford, Cambridge, Huntingdon, Sandy, and Wellingboro system, at page 5, the foot note renders the various points connected with the working of the traffic on those lines quite intelligible to the merest tyro in railway affairs.

Had Mr. Airey published his very interesting and useful work on Railway Junction Diagrams some fifteen years ago, we sincerely believe that the very perfect mechanical means only now, or until very recently, introduced at railway junctions, to provide for the public safety, would have been long ago generally adopted, and the enormous sacrifice of human life and property which have occurred during that period from accidents at junctions would have been either entirely avoided, or the consequences have been very greatly mitigated, for what would have so well aided the efforts of such able and zealous scientific labourers in that cause as Mr. John Saxby and his talented coadjutor, Mr. J. S. Farmer, as calling public attention—in the very telling way Mr. Airey has done—to the absolute necessity for providing proper and sufficient means for conducting the traffic at railway junctions with safety and success?

What Messrs. Saxby and Farmer have done for railway companies, and for the safety of the travelling public, by the invention and introduction of their highly ingenious and really beautiful mechanical contrivances for working railway points and signals in conjunction, so that there can never be confliction between the signals themselves, or between the points and the signals, Mr. Airey has now done for all who are interested in railway working, and in the interchange of traffic on railways.

No class of persons connected with railways is better able to appreciate the value of Mr. Airey's labours than the engineer who may be interested in railway projection, construction, or working, as by such, a reliable work of reference of this kind will be found to be of the greatest service. Members of parliamentary committees, who are too often bamboozled by the advocates of rival schemes, will find in Mr. Airey's work an independent means of information upon the subject of which it treats. The resident engineer and the traffic manager of new lines (*feeders and bleeders*) will find much therein that will guide them in the proper management of their junctions and traffic-working; and the shareholders and the public interested in railway property, and in the vital question affecting public safety in railway travelling, will find Mr. Airey's book a desideratum, and must agree with us that a considerable amount of well-merited praise is due to Mr. Airey for the admirable manner in which he has performed a highly important task for the benefit alike of those interested in railway property, and in the questions affecting the safety of human life and property in transit on the railways of Great Britain.

Inventors and Inventions; In three parts: The Philosophy of Invention; The Rights and Wrongs of Inventors; and Early Inventors' Inventories of Secret Inventions. By Henry Dircks, C.E., F.C.S., &c. Post, 8vo. Spon, 48, Charing-cross. P.p. 256.

This work, dedicated by its author to Mr. Henry Bessemer, is designed to maintain the rights of inventors, and (as expressed in the introduction), as far as possible, to promote remedial measures for securing their true position and ameliorating their wrongs. Inventors have risen to an important position, the products of their ingenuity have improved and enlarged manufacturing operations, and vast fortunes have arisen from their labours. It becomes important, therefore, that their efforts when made the subjects of patents, should, while securing the inventor, prove at the same time no burthen to the public—meaning by *the public*, the million, the community at large.

Mr. Dircks's treatise developes the progress of invention from the thirteenth to the seventeenth century in a series of curious inventories of "Secret Inventions." This was a course adopted previous to the introduction of the patent system, and even after its introduction, before specifications existed, none being required in early grants. Indeed, "The first 'Specification' enrolled does not bear date earlier than the 3rd October, 1711" (page 187). With the advance of inventive skill, patents acquired a steadily increasing value and importance, and at the present time they would almost appear to have outgrown the laws designed for the security of this special class of property. Not only in the history of inventions, but in their legal discussion likewise, the most arbitrary language is employed, there being no standard other than the varying opinions of the learned, whose authority is again open to comment and perverse readings. In his "Philosophy of Invention," Mr. Dircks justly observes: "The commonwealth of science is world-wide; it is so universal as to acknowledge no sect or party; it makes no national distinctions to limit the boundary as to where or by whom a *discovery* was made, a great *invention* projected, or an important *improvement* first brought to light." After making some general observations, he consequentially considers Theory, Experiment, Discovery, &c.; and it is not until we have gone through these preliminary stages that we arrive at Invention, Improvement, Design, &c. He remarks: "By means of these mental and practical processes we establish a knowledge of the nature and properties of phenomena and governing principles which we find capable of numerous practical applications. We may distinguish the first as investigations purely mental and scientific; the other as applications which are useful and commercial adaptations arising out of such acquired knowledge" (page 65).

This first portion of the work is so entirely original, and has such a thoroughly practical bearing, that it cannot fail to excite considerable interest and discussion, supplying as it does a serious omission in all our Technological and other Dictionaries, and its subject never having been previously systematised and rigorously defined.

In 1865 was published the "Report" of the Patent-Law Commissioners, being evidence obtained in the years 1862-3-4 while at meetings of the British Association in 1864-5; the Rev. J. E. T. Rogers, Professor of Political Economy, Oxford, read papers denouncing patent monopoly as injurious alike to inventors and the public; and further, in 1863-4, R. A. Macfie, Esq., of Liverpool, published a pampblet to the same effect. The subject also was taken up by the *Times*, which, in 1863-4-5, sided with the "anti-monopolists." All the points discussed through these several sources Mr. Dircks has selected, arranged, and very carefully examined in a most dispassionate and apparently satisfactory manner.

His main argument in treating of "The Rights and Wrongs of Inventors," is that inventions, and consequently patents, benefit the public or community at large, and that they are not injurious, as pretended, to that lesser or legal "public," the manufacturers; but that the latter, although they are really the direct patrons of patentees, they are so less on any principle of approving of the system than from the necessity of the case, as they have no alternative but to support the inventor or allow his patented improvements to become the means of raising small capitalists; and, therefore, as he says: "It may seem a paradox, but it is no less true, that inventors' patrons are among their most inveterate opponents." In his 5th Chapter, the author gives an interesting critical examination of Sir William G. Armstrong's remarkable evidence given by him in 1863, showing the fallacy of his opinions in reference to inventions, and particularly as affecting patents, which he desired to see abolished.

The "Inventories of Secret Inventions" are given to show the position of inventors previous to the granting of patents, and to the obligation to supply a "Specification." And such, Mr. Dircks contends, would again be the result of doing away with the present patent-laws. He justly considers that this miscellany "affords indisputable evidence of the large amount of ingenuity that has been lost, the early possession of which could not otherwise than have largely contributed to the progress of arts, sciences, and civilisation." And assuming the continued opposition to patents, let the advocates of Patent-Law abolition bear in mind the fraudulent practices which a system of "secrets" is calculated to favour, and, instead of thus showing themselves as "the charlatan's best friend," let them reconsider the untenable character of all the arguments hitherto raised against a man's monopoly of his own inventions whether they be scientific or literary productions.

A work of this nature is calculated to prove highly useful to inventors, patentees, and all classes of scientific readers. Its style is very condensed, and the mass and wide range of information it contains could only result from the possession of large experience in the matter of inventions.

LATEST PRICES IN THE LONDON METAL MARKET.

	From			To		
	£	s.	d.	£	s.	d.
COPPER.						
Best selected, per ton	79	0	0	80	0	0
Tough cake and tile do.	75	0	0	77	0	0
Sheathing and sheets do.	79	10	0	80	0	0
Bolts do.	83	0	0	"	"	"
Bottoms do.	88	0	0	"	"	"
Old (exchange) do.	72	0	0	"	"	"
Burra Burra do.	84	0	0	"	"	"
Wire, per lb.	0	0	$11\frac{1}{4}$	"	"	"
Tubes do.	0	0	$11\frac{3}{4}$	"	"	"
BRASS.						
Sheets, per lb.	0	0	9	0	0	$9\frac{1}{2}$
Wire do.	0	0	$8\frac{1}{2}$	0	0	$9\frac{1}{2}$
Tubes do.	0	0	$10\frac{3}{4}$	"	"	"
Yellow metal sheath do.	0	0	7	0	0	$7\frac{1}{4}$
Sheets do.	0	0	$6\frac{7}{8}$	0	0	7
SPELTER.						
Foreign on the spot, per ton	21	0	0	"	"	"
Do. to arrive	21	0	0	"	"	"
ZINC.						
In sheets, per ton	25	10	0	26	0	0
TIN.						
English blocks, per ton	91	0	0	"	"	"
Do. bars (in barrels) do.	92	0	0	"	"	"
Do. refined do.	94	0	0	"	"	"
Banca do.	93	0	0	"	"	"
Straits do.	87	10	0	"	"	"
TIN PLATES.*						
IC. charcoal, 1st quality, per box	1	8	0	1	10	0
IX. do. 1st quality do.	1	14	0	1	16	0
IC. do. 2nd quality do.	1	6	0	1	8	0
IX. do. 2nd quality do.	1	12	0	1	14	0
IC. Coke do.	1	4	0	1	6	0
IX. do. do.	1	10	0	1	12	0
Canada plates, per ton	13	10	0	"	"	"
Do. at works do.	12	10	0	"	"	"
IRON.						
Bars, Welsh, in London, per ton	6	10	0	"	"	"
Do. to arrive do.	6	10	0	"	"	"
Nail rods do.	7	0	0	7	10	0
Stafford in London do.	7	10	0	8	10	0
Bars do. do.	7	10	0	9	10	0
Hoops do. do.	8	10	0	9	12	6
Sheets, single, do.	9	5	0	10	0	0
Pig No. 1 in Wales do.	3	15	0	4	5	0
Refined metal do.	4	0	0	5	0	0
Bars, common, do.	5	10	0	6	0	0
Do. mrch. Tyne or Tees do.	6	10	0	"	"	"
Do. railway, in Wales, do.	5	10	0	6	0	0
Do. Swedish in London do.	10	5	0	10	10	0
To arrive do.	10	5	0	"	"	"
Pig No. 1 in Clyde do.	2	14	0	3	2	6
Do. f.o.b. Tyne or Tees do.	2	9	6	"	"	"
Do. No. 3 and 4 f.o.b. do.	2	6	6	2	7	0
Railway chairs do.	5	10	0	5	15	0
Do. spikes do.	11	0	0	12	0	0
Indian charcoal pig in London do.	7	0	0	7	10	0
STEEL.						
Swedish in kegs (rolled), per ton	14	5	0	"	"	"
Do. (hammered) do.	15	0	0	"	"	"
Do. in faggots do.	16	0	0	"	"	"
English spring do.	17	0	0	23	0	0
QUICKSILVER, per bottle	6	17	0	"	"	"
LEAD.						
English pig, common, per ton	19	15	0	"	"	"
Ditto. L.B. do.	20	0	0	"	"	"
Do. W.B. do.	21	15	0	"	"	"
Do., ordinary soft, do.†	20	0	0	"	"	"
Do. sheet, do.	20	15	0	"	"	"
Do. red lead do.	21	0	0	"	"	"
Do. white do.	27	0	0	30	0	0
Do. patent shot do.	23	0	0	"	"	"
Spanish do.	19	10	0	"	"	"

* At the works 1s. to 1s. 6d. per box less.
† A Derbyshire quotation, not generally known in the London market.

The Shrewd, Ingenious Scotch.—The examination of witnesses before the Select Committee of the House of Commons on the Forth and Clyde Junction, &c., Bill, affords an insight into their railway economics that is highly interesting, if not positively instructive. The distance from Gartness to Glasgow is 51 miles, whereas the distance from Gartness to Glasgow by way of Ballock is only 28 miles. "We send goods by the round about route to Glasgow by way of Sterling, because it is our interest to get paid upon as long a mileage as possible, and that is the longest way." The difference between the principle here avowed, and that which distinguished the Sheffield man Broadhead, may be in degree only.

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Important Master and Workman's Case.—A case of considerable importance to workmen was decided in the Greenock Small Debt Court, on the 12th ult. The summons set forth that "Messrs. M'Nab and Co., engineers and iron shipbuilders, Greenock, are due to Robert Ralston, painter, Greenock, the sum of £3 11s. stg., for work done by him to them from the 9th of May, 1867, till 23rd May, 1867." The defenders pleaded non-liability in consequence of the pursuer having by a breach of the rules under which he was engaged forfeited his wages. The circumstances of the case are as follows:—The pursuer, together with four other painters, was engaged painting the new screw steamer *Galvanic*, which was then lying in Messrs. Caird and Co.'s dock, and was being finished by Messrs. M'Nab and Co. It had been intimated to the latter firm on the 23rd May, that the vessel could only be allowed to remain in the dock till the following Saturday. On the day in question Messrs. M'Nab and Co.'s foreman painter found that it would be impossible for the five painters who were engaged upon the vessel to have her finished by Saturday night, and as he (the foreman) had done all in his power to get additional men but failed, he resolved, as the work to be done was comparatively coarse, to employ a number of apprentice carpenters to assist the painters. Thereupon, the five painters intimated that unless the apprentices were dismissed from the work they would leave. The foreman having refused to comply with the request of the men, the latter left, and the pursuer then claimed the wages due him for work done by him up till the hour of leaving. It was stated for the pursuer that it was customary for employers to dismiss men without notice, and that as men were in the habit of leaving employers upon similar terms, the defenders were bound to pay the pursuer for work done between the dates specified in the summons, without reference to the cause of his leaving. On the other hand, Messrs. M'Nab and Co.'s solicitor stated that the pursuer, together with all the other workmen employed by the defenders, were engaged under conditions of certain rules, which were hung up in five prominent places of the works. These rules only came into operation upon the termination of the late lock-out in the building trades. The rules were drawn up by the Clyde Shipbuilders and Engineer's Association Committee, and approved of at a general meeting of the association on 18th July, 1866, and all persons now employed in the works of members "are engaged on condition that they shall observe the following rules and regulations;" five or six being as follows:—V. *Wages.*—The wages will be reckoned by the hour, and paid fortnightly on such day and at such hour as may be appointed by the employer, subject to retention for such lying time as is usual in the works. If a workman is dismissed during the currency of a fortnight he will receive his wages at the time of dismissal unless he be dismissed for a breach of these rules. If a workman who has not rendered himself liable to dismissal leaves the employment of his own accord, during the currency of a fortnight, he will receive the wages which he has earned on the usual pay day. Workmen entering upon employment and absenting themselves without permission before they have completed one days's work will not be entitled to any payment for the time during which they may have worked. VI. *Interfering with workmen.*—Any workman or class of workmen interfering with, annoying, or molesting other workmen, or dictating as to how such should he employed, or paid, will be subject to instant dismissal and forfeiture of the whole wages then due. The pursuer, along with other workmen, having been guilty of a breach of rule No. 7, in so far as they dictated as to how certain workmen should be employed, had clearly forfeited their wages. The rules having been admitted, evidence adduced, and the solicitors on both sides having been heard, the Sheriff said: The first question which arose was, what were the rules upon which the pursuer entered upon his engagement? It was clear that it was under the rules, a copy of which he held in his hand, and it would appear that five copies had been put up in various parts of the works. He maintained that the workmen, if they did not do so, ought to have made themselves acquainted with them. Now, there was no dispute in this case about the pursuer having earned the wages sued for; but the question before the Court was—Did anything occur by which these wages so earned had been forfeited? After referring to, and reading the two rules above quoted, the Sheriff said, with reference to rule 6, he could not say it was an unreasonable rule, nor could he see any reason in law why it should not be given effect to. The pursuer had certainly not brought himself under the first part of it, but it was perfectly evident that he had dictated how other men should be employed. It is true that no violence, impertinence, or ill treatment had been used, but in the way in which the pursuer had acted it was clear, according to this rule, that he had subjected himself to forfeiture of his wages. After detailing the circumstances connected with the men leaving their employment, his Lordship said: When workmen suddenly leave in the middle of a piece of work, when the want of their services must seriously embarrass an employer, because other men are employed to assist them, he could entertain no other opinion but that it was an attempt on the part of the men so leaving to dictate to the master, and consequently, as the agreement was a fair and legitimate one in this case between the parties, and the pursuer having broken it, he was clearly of opinion that he had forfeited his wages, and decree was accordingly given in favour of the defenders.

NOTES AND NOVELTIES.

NOTICE.—In consequence of press of matter from the Paris Exhibition we are compelled to allow several important communications to stand over until our issue of September.

MISCELLANEOUS.

Glasgow Athenæum.—The result of the examinations held in connection with the

Society of Arts, London, in April last, has just been published. The candidates from the Glasgow Athenæum have, as in former years, been very successful. The number of certificates awarded to them has been as follows:—9 first class, 15 second class, and 9 third class; in all, 33. Athenæum candidates have also carried off the first and second prizes in French, and the second prize in English literature.

Sugar.—Whilst we are patiently waiting for our colonial growers of sugar-cane to get out of the rut into which indolence has thrown, and perpetuated them, we may see our continental rivals in industry increasing their resources, and actually competing successfully with their beet-root sugars. According to Herr Burger's "Circular," no fewer than fifteen additional sugar factories have been erected in France during the past year, besides a considerable number in Austria and Poland. The Americans are aiming to achieve a similar success. They have formed a company, with a capital of three million dollars, and will begin in Illinois. The machinery has been made in France, and a special Act of Congress admits that machinery "duty free." Cannot Ireland sweeten her tea after the same fashion? There is nothing to hinder her—absolutely nothing at all at all. It is high time she indulged in the sweets of life by industry, which is justice to Ireland.

Highland and Agricultural Society of Scotland.—The annual show of this society was held at Glasgow on the 29th of June and following days, concluding on the 1st of July. The collection of agricultural machinery and implements exceeded in number and interest those exhibited at previous shows.

Mr. G. R. Stephenson's Yacht.—The *George Crow* steam-yacht (named after her owner's principal foreman) was launched by Messrs. C. Mitchell and Co., of Low Walker. She will be principally employed in sailing about the lochs and islands of the Kyles, where Mr. Stephenson has purchased an estate. Messrs. Stephenson have supplied the yacht with two oscillating engines of 12 horse-power.

The American 15-in. Guns.—The "Army and Navy Journal" has an article on the 15in. Rodman guns, in which it states that the American "mammoth" powder is so much weaker than ordinary cannon powder, that 50lbs. of the former are practically equal to but 35lbs. of the latter. In the navy, however, the charge of ordinary cannon powder has now been increased to 60lbs., and in the American army, charges of 100lbs. have lately been fired from these guns, giving to the solid shot of 450lbs. an initial velocity of about 1,600ft. per scond.

The Russian Railways.—A despatch from St. Petersburg, published in the *Times* of 18th July, states that the St. Petersburg and Moscow Railway has been sold to the Messrs. Winans, who have so long worked the line by contract. They are the owners of the well-known Winans' yacht, or cigar ship, which we have noticed from time to time. As Messrs. Winans constructed the railway originally, and have since worked or maintained it, they are well qualified to estimate its value.

Dewit's Steam and Vacuum Gauges, of which we gave a notice in our issue of May last, have of late been extensively adopted by engineers in this country. While the double-diaphragm gauge is especially adapted to hydraulic purposes, the Bourdon or elliptic tube gauges manufactured by Messrs. Dewit are chiefly applied to marine engines; the new 6in. size is used more particularly for river boats and other small crafts. The Bourdon locomotive gauge is fitted with an "anti-frost" arrangement, by means of which the bursting of the gauge tube is prevented when the steam is down. For land engines the single diaphragm gauge is better adapted. We understand that Mr. A. Dixon, of Adam-street, has been appointed by Messrs. Dewit their sole agent for the United Kingdom.

Three Artesian Wells are being sunk near Paris at present and are in fair progress. The first of these is at Les Cailles, the two others at the Boulevard de Gare and the Chapelle-Saint-Denis.

A Genoa and Brazil line of steamers is about to be started. Three vessels, viz., the *Bourgoyne*, the *Picardie*, and the *Poitou*, have been purchased for this purpose by the Marseilles Société Générale des Transports Maritimes. The route of these steamers will be from Genoa *via* Marseilles, Barcelona, Cadix, and St. Vincent to Pernambuco, and from thence to Bahia, Rio-de-Janeiro, Montevideo, and Buenos-Ayres.

Coal in Poland.—Borings are continued the whole length of the railway lines in the Kingdom of Poland; these operations, which have already led to the discovery of four seams of coal, have now obtained a still farther success, as a fifth seam has just been found at Dombroff, and a sixth in the forest of Stohemeschiton.

A Steel Screw Propeller, cast by Messrs. Naylor, Vickers and Co., of Sheffield, has been fitted to the steamer *Bradford*, plying between Grimsby and Rotterdam. This screw is three-bladed and has a diameter of 10ft. 2in. by 21ft. pitch; its weight is 1 ton 18 cwt. 3qr., whilst the cast iron propeller of the sister steamer *Leeds*, having the same dimensions, weighs 2 tons 12 cwt. 2qr., or 13 cwt. 3 qr. more than the cast steel propeller.

STEAM SHIPPING.

The Overloading of Ships.—The *Times* explains that of the ships annually reported as "missing," a very large proportion is lost from being employed on voyages which overtask their size and strength. Last year five British screw steamers passed the Scaw on the 29th of December, bound for England, four laden with grain, and the fifth with grain and cattle. The four grain vessels were of a tonnage and power of engines so small as to render them incapable of contending with a winter gale in the North Sea. Deep laden and with high bulwarks, the open spaces between their poops and forecastles were simply wells to retain the water which broke on board of them. The fifth vessel, the *Mary* of Loudon, was larger and more powerful, and she had a spar deck which prevented any lodgment of water in her. These advantages enabled the *Mary* to weather easily the gale (in which the other four steamers foundered), without damage to machinery, hull, boats, spars, or rigging, and with the loss of only a single bullock. Whether vessels make their port or founder at sea matters but little to owners who are well protected by insurance, but it does matter to the widows and orphans of the crews whose lives are thus wickedly and wantonly squandered.

RAILWAYS.

The Mont Cenis Railway.—The *Journal de Savoie* stated, a short time ago, that a vein of quartz which did not admit of an advance of more than 2½ft. per day, on the French side, having been got through, and one of much softer stone having succeeded, the perforating machines were now able to accomplish double that distance, or 5ft., which would, by certain improvements in the machinery, soon be increased to 6ft. or 7ft. per diem. It was added that after the section now worked a portion of schist, equally friable, would be entered on, which had been reached already on the Italian side; that the united progress would thus amount to 13ft. per diem, and the tunnel be completed within four years. Mr. Brunless, the engineer to the Mont Cenis Railway Company, writes to deny the accuracy of these statements. He sends specimens of gypsum, met at 2,462 metres, and hard compact limestone met at 2,510 metres from the Modane end. No more than 48 metres having been worked in softer materials, Mr. Brunless thinks that the position of the hard compact limestone now just commenced, verifies the accuracy of the geological survey on which Mr. Conte made his report, and he anticipates that there are from 2,000 to 3,000 metres of the material to be got through. His calculation of the time required to finish the tunnel was based on this report, and he sees no reason whatever for expecting an earlier completion of the work. As regards the Italian side, it was stated in a recent number of the *Opinione*, of Florence, that the tunnelling operations on that side are progressing satisfactorily.

ACCIDENTS.

The Victoria Bridge, on the Ormiston and Monktonhall branch on the North British Railway, fell, on May 31st, with a loud crash, killing one man, and seriously injuring two others. A waggon laden with stones was being propelled across the bridge by labourers, when the woodwork suddenly gave way. The men, waggon, and stones were precipitated to the ground, a distance of 30ft. It is stated that the woodwork of the bridge was in a very decayed state, having been in use about twenty-eight years.

The Practice of Packing Luggage on the roofs of passenger carriages is animadverted upon, in a late Board of Trade report, as a cause of railway accidents. Captain Tyler says that luggage packed in this manner is always liable to be set on fire by burning matters from the furnace of the engine, that it obstructs the view of the guards along the tops of the carriages, which it makes top-heavy, and remains liable to fall over in the event of their leaving the rails. A fire arose lately from this cause, near Newark, in luggage packed on an express passenger train of the Great Northern Railway.

DOCKS, HARBOURS, BRIDGES.

Improvements at Port Glasgow.—The Town Council and Harbour Trust of Port Glasgow have accepted the tender of Mr. Robert Laing, Port Glasgow, for the construction of a main intercepting sewer, at a cost of £1,581 5s., was accepted. A committee, consisting of Bailies Harvey and Livingston, and Messrs. Birkmyre and Haggart, were appointed to prepare rules and regulations, and a table of rates, previous to the introduction of the additional water supply, which was expected to be introduced in a short time. It was agreed to accept the offer of Messrs. York, Greenock, of £25 per week for the use of the dredger, and 5s. per day for the use of ten punts, the contractor to pay wages of working expenses. The monthly statement submitted by the treasurer showed an increased revenue of £487 10s. 9d., compared with the corresponding month of the previous year. The propriety of levying dues on vessels laying up in the harbours was remitted to the Committee of Management.

New Dock at Bombay.—By telegram received in London on the 22nd ult., we are informed that the new dock at Bombay was formally opened on the 17th June.

The Moerdyk Bridge.—It is stated that Mr. Sedley has tendered to construct and erect the Moerdyk Bridge on his patent system for the sum of £636,000. Eleven of the spans of this structure, as designed by Mr. Sedley, are each about 400ft., a width of opening in excess of that required by the Dutch Government. As the superstructure is, however, much less expensive than in the ordinary system of bridge building, it proved more economical to diminish the number of piers, and the consequent cost of the foundations, at the expense of a certain additional weight in the superstructure.

MINES, METALLURGY, &c.

Scotch Gas Coals.—The Rochsoles gas coal, of Airdrie, is a mineral nearly allied to the celebrated Boghead coal, and produces a rich return in gas. As this class of coal is becoming year by year more scarce, its value has been enhanced; and it is well known that the output of the best kinds has been contracted for while the seam lasts. On the other hand, several new pits have been opened, whose produce would have naturally come in to supply the deficiency; but these were conserved for oil distillation, and the overplus of the old works was as anxiously secured for the same purpose. Since that time oil distillation has nearly ceased, and the proprietors of the various seams of gas coal are now freely offering their mineral for sale. By an analysis of some Scotch gas coals, Professor Fyfe, of Aberdeen, supplies the following results:—

Boghead	15,486 cubic feet per ton of coal.		
Arniston	10,500	„	„
Lesmahagow	10,176	„	„

Mr. Young, of Dalkeith Gasworks, subjected 26cwt. of the Rochsoles coal to the test, and found that it yielded 11,902 cubic feet of gas to the ton of coal. The following is a full analysis of a commercial sample of Rochsoles gas coal, consisting of 26cwt. The deductions arrived at were made from working the entire sample, as in the ordinary practice in gas-making. 6,000 cubic feet of the gas were stored for examination; 1,000 parts of the coal gave the following:—

Volatile matter (gas, tar, and water) per cent.	46·05
Fixed combustible matter (fuel)	20·75
Ash	31.02
Sulphur	1·28
Water	0·90 = 100·00

WATER SUPPLY.

Helensburgh Water Works.—The Helensburgh Town Council have accepted the following two tenders for the carrying out of the necessary work required for the water supply of the town, viz.:—From Mr. Robert Simpson, for the formation of the reservoir, cutting, digging, &c., £3,910 17s. 3d.; and from Messrs. Thos. Leadbetter and Co., Glasgow, for the pipes, &c., £3,636. These, together, amount to £7,546 17s. 3d., and, adding the sum to be paid to Sir James Colquhoun for ground, &c., and the engineer's charges, the work will cost in all about £8,000—a small sum for such a boon as a supply of water equal to the wants of a population such as that of Helensburgh. It is stipulated with the contractors that the works be completed by November next. They are to be upon the gravitation principle. The ceremony of cutting the first sod took place on the 22nd ult., the operator being Sir James Colquhoun, of Luss, Bart., who performed his task very neatly, and amidst the applause of the assembled spectators. Thereafter a few appropriate toasts were duly honoured. The ceremony took place at the site of the reservoir about a mile and a half to the north of the town.

APPLIED CHEMISTRY.

Noxious Vapours from Alkali Works.—Dr. R. Angus Smith, the Government inspector appointed under the provisions of the Alkali Act, has presented his report for 1866, from which it is satisfactory to learn that a further advance has been made in the manner of preventing the escape of muriatic acid during the processes of manufacture of various salts, the amount of escape last year being 0.73, against 0.88 of the preceding year. This improvement, small though it be in apparent amount, is a real benefit to the residents in the neighbourhood of chemical manufactures, as the difference of 0.15 represents more than 15 cwt. of muriatic acid per diem, or 4½ tons per week. The condensation of the dangerous acid is thus shown to be generally satisfactory, although some allowance must be still made for leakage, which it is difficult to estimate, and which it requires increased vigilance and possibly an amendment of the Act to prevent. The manufacture of chemical salts appears to be still increasing, the amount of salt decomposed during the first year of inspection having been 283,000 tons, in the second 310,000 tons, and during the third (1866) 371,950 tons. The report adds—"It is possible to do a little more by careful management of the powers granted by the Act, chiefly by giving permanence to the habits begun, and giving stability to work which had been hastily done to meet the exigencies of the occasion, although impossible to use the Act so as to satisfy all the demands of the public when the works are in a very crowded district. The inspector can only see that the proper arrangements are made and that they are in order when he makes his visits. At all other periods he must leave the public to watch."

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated May 31st, 1867.

1618 J. Le Butt—Hay making machines
1619 T. Porter—Holding music
1620 James Earl of Caithness—Ships' compasses
1621 R. Reece—Producing cold
1622 J. Lancelot—Ornamental chains and bands
1623 P. Lawrence—Applying adhesive agents to light materials, &c.
1624 A. M. Clark—Applying and regulating motive power

Dated June 1st, 1867.

1625 T. Poultney—Revolving firearms
1626 T. Poultney—Breech loading firearms
1627 W. Bradford—Construction of boats, &c.
1628 A. G. Schaeffer—Obtaining increased light in the combustion of illuminating matters
1629 F. B. Houghton—Steam boilers, &c.
1630 A. Albright—Covering buckles, &c.
1631 E. Tayler—Arranging of type

Dated June 3rd, 1867.

1632 T. Horrex—Hatching eggs
1633 W. Pidding—Improvements in reels
1634 E. McLean—Pianofortes and harmoniums
1635 W. H. Richardson—Manufacture of iron and steel
1636 J. F. Brown—Looms for weaving
1637 C. L. J. Carville—Construction of boilers
1638 D. Barker—Drying artificial fuel and other substances
1639 S. Harwood—Construction of walls, &c.
1640 R. W. Page—Hand garden engines and hydropults

Dated June 4th, 1867.

1641 J. Inshaw—Electrical clocks
1642 M. Cavanagh—Adjustable lock spindles
1643 J. Waddington and B. Longbottom—Moulds for casting metals
1644 G. Davies—Paddle wheels
1645 T. Laidlaw—Yarns used for weaving textile fabrics
1646 E. Meldrum—Purification of paraffin
1647 J. H. Johnson—Holders for whips
1648 J. McOwen—Fire grates
1649 H. W. Hart—Construction of raft

Dated June 5th, 1867.

1650 D. Hanson—Construction of steam boilers
1651 J. Gaudet—Apparatus for preventing accidents on railways
1652 N. Rauch and E. L. Darlet—Manufacture of artificial fuel
1653 T. H. Saunders—Gas stove
1654 C. Boulay—Galvanic batteries
1655 G. White—Hydrate and carbonates of soda
1656 L. B. Schmolle—Crinoline skirts
1657 I. Evans—Spring hooks
1658 I. M. Milbank—Breech loading firearms and cartridges adopted to such arms

Dated June 6th, 1867.

1659 J. Adams—Printing tickets
1660 B. Templar—Fastenings for window sashes
1661 E. Bland—Steam engines
1662 J. Livesey—Paper folding machines
1663 T. Brown—Artificial limbs
1664 T. Wilson—Breech loading firearms
1665 R. Maynard—Chaff cutting machine
1666 E. Ellis—Twist lace machinery
1667 G. R. Turner and W. T. Allen—Gates and fences

Dated June 7th, 1867.

1668 T. Sturgeon—Street and similar lamps
1669 C. E. Giojoln, J. H. Gray, and P. Martinengo—Inkstands
1670 A. Elvins—Breech loading firearms
1671 A. L. Bricknell—Rotary pumps
1672 J. Offord—Signalling between different parts of railway trains
1673 H. Crowe—Hot water apparatus
1674 E. S. Atkinson—Treatment of oakum
1675 D. Rorison—Arrangement of reeds to be used in looms for weaving
1676 J. Petrzywalski—Camera obscura
1677 E. T. Hughes—Sewing machines
1678 W. W. Wood and J. Wood—Fitting the tubes in the flues of steam boilers
1679 J. Sheldon—Brushes
1680 A. Barry—Communicating motion to cranes
1681 J. Offord—Vehicles
1682 W. Tribe—Velocipedes, &c.
1683 R. Scott, J. Nixon, and J. Beaumont—Certain descriptions of woollen cloths
1684 J. Warburton—Registering and recording the quality of gas

Dated June 8th, 1867.

1685 J. Horton—Flyers employed in spinning and twisting fibrous materials
1686 H. Parker—Tobacco pipes
1687 F. Glisenti—Gun barrels
1688 J. Collier, R. Howarth, and W. Cryer—Knitting healds
1689 J. C. Ralston—Making candles by dipping
1690 H. Wills, G. Rice, and A. Maxfield—Sewing machines
1691 J. Hargreaves—Obtaining motive power
1692 J. Turner and R. B. Dunnett—Stamping machine
1693 O. Barrett and H. Leggott—Knife cleaner
1694 N. Thompson—Connecting together pipes or tubes, &c.
1695 A. Parkes—Ornamenting surfaces of paper, &c.
1696 R. E. Pepys and J. Warburton—Securing cords and straps
1697 H. Rolle—Propeller for vessels

Dated June 10th, 1867.

1698 J. Crompton—Revivifying beverages and warming them
1699 W. French—Roughing animals
1700 J. Macintosh—Application of plastic and fibrous materials to the manufacture of moulded articles
1701 T. Robinson and J. Pierce—Manufacture of zinc
1702 A. L. Dowie and R. McIntyre—Punching, cutting, and embossing
1703 J. H. Kerley—Fastenings for brooches
1704 F. B. Dœring—Engines for boring rock, &c.
1705 J. Conolly—Obtaining motive power
1706 T. Holt—Steam boilers
1707 W. Orr—Separating moisture from substances
1708 R. Logan—Securing and adjusting windows, blinds, &c.

Dated June 11th, 1867.

1709 R. Hornsby, J. Bonnall, and H. Shield—Machines for dressing and separating grain, &c.
1710 H. A. Bonneville—Vessels
1711 C. Toft—Cruet frames
1712 J. Graham—Mixture for bleaching vegetable fibres
1713 H. Fletcher—Artificial fuel
1714 J. H. Johnson—Rolling and shaping metals
1715 G. F. Hill—Boxes, &c.
1716 J. Thom—Apparatus to be employed in expressing oils and fatty matters
1717 S. W. Wood—Moving grain, &c.
1718 J. Fletcher—Retorts for manufacturing and reburning animal charcoal
1719 W. Rowan—Cleaning flax, &c.
1720 J. C. Fuller—Telegraphic insulators

Dated June 12th, 1867.

1721 J. Millward—Combined step cover and wheel fender for vehicles
1722 J. F. Boëtius and J. Eichhorn—Types for printing
1723 J. Cochrane—Pontoon bridge
1724 C. D. Abel—Appliances for horse shoes as a substitute for roughing
1725 D. Crichton, W. Donbavand, and D. Crighton—Looms for weaving
1726 F. D. Frost—Rollers used in frames for preparing fibrous materials
1727 J. H. Snelson—Axles and boxes, and securing wheels thereto
1728 A. M. Clark—White lead

Dated June 13th, 1867.

1729 T. S. Prideaux—Improving wine on draught
1730 E. T. Hughes—Manufacture of brushes
1731 A. C. Lion—Chains, bracelets, &c.
1732 J. Holmes—Drain bottoms, &c.
1733 F. B. Baker and L. Lindley—Stretching and finishing lace, &c.
1734 R. H. Barton—Preparation of fibrous materials
1735 J. Glover—Furnaces for steam boilers, &c.
1736 S. Hancock—Signalling to and from railway trains

Dated June 14th, 1867.

1737 W. King—Apparatus for communicating between the guard and driver and passengers and guard of a railway train
1738 C. Askew—Refrigerators for cooling liquids
1739 S. Tuddenham—Iron or metal bars for balconies, &c.
1740 D. E. McMahon—Saddles
1741 H. H. Bryant—Fireproof safe
1742 S. E. Crow—Apparatus to be used in connection with steam boiler and other furnaces
1743 G. Ker—Finishing garments after cleaning or dyeing

Dated June 15th, 1867

1744 J. Fletcher and W. Carr—Machines for sizing yarns preparatory to weaving
1745 J. Quinn—Fire escape
1746 T. Walker—A spring hook
1747 J. Onions—Iron and steel
1748 G. McKenzie—Illuminating gas
1749 C. Sadler—Furnaces for consuming smoke
1750 R. Beord—Flexible galvanic batteries
1751 A. M. Clark—Means of cooling beverages
1752 W. E. Newton—Preparation of pulp for the manufacture of paper
1753 G. Allix—Drilling and hoisting machines
1754 C. Erba—Depilation and leather tanning
1755 C. Varley and S. A. Varley—Improvements in electric telegraphs
1756 W. R. Lake—Saws and saw teeth
1757 G. Clark—Guns, &c.
1758 L. J. Crossley and J. Sunderland—Oiling wool or fibre

Dated June 17th, 1867.

1759 R. W. Barnes—Metallic pens and penholders conjointly
1760 J. Meiklejon—Lifting, lowering, and transporting heavy bodies
1761 J. Fletcher and W. Carr—Sewing machines
1762 C. D. Abel—Utilising the power spent in retarding the motion of vehicles and machinery
1763 J. H. Johnson—Wood screws
1764 W. R. Lake—Railway carriages and brakes
1765 J. Welch—Swivels
1766 J. E. Boyce and R. Horrington—Umbrellas and parasols
1767 F. B. Miller—Toughening brittle gold bullion
1768 I. G. Lloyd—Compressing air
1769 G. T. Bousfield—Indicating time by time keepers
1770 M. Gray—Manufacture of electrical telegraph conductors
1771 M. Gray and L. Gibson—Examining the coating of electric telegraph communicators
1772 M. Gray—Electric telegraph conductors, &c.
1773 W. Cooke—Registering the number of passengers in vehicles
1774 D. Sowden and R. C. Stephenson—Looms for weaving
1775 Sir T. Tancred—Construction of beehives
1776 P. Welch—Dressing printers' types

Dated June 18th, 1867.

1777 W. Fairley—Preventing over winding in mines
1778 J. M. Frost—Raising sunken vessels
1779 C. D. Abel—Repeating striking movement in watches, &c.
1780 R. Bodmer—Securing the nuts of bolts
1781 J. Edwards—Lifts and tubs for raising minerals from pits, &c.
1782 T. Brown—Holding and lifting plates and dishes
1783 J. G. Jones—Getting minerals
1784 W. S. Thompson—Construction of heating and annealing furnaces
1785 J. Lang—Breech loading firearms

Dated June 19th, 1867.

1786 D. Jones—Coal vases, &c.
1787 F. W. Waide—Obtaining motive power
1788 L. Simon—Machine for bronzing
1789 M. Lyons—Making frames for looking glasses
1790 J. Coppard—Closing of doors, &c.
1791 E. W. Hughes and T. H. Head—Rotary engines and pumps
1792 A. L. Pauter—Seat for young children
1793 H. C. Hurry—Stop blocks and buffer stops to be used on railways
1794 W. MacLellan—Railway buffers
1795 J. H. Johnson—Treatment of yarns
1796 J. E. Whiting—Construction of castors

Dated June 20th, 1867.

1797 D. Jones—Handles for articles of hollow ware
1798 A. M. Clark—Sewing saddlery, &c.
1799 T. Wilson—Moveable spanners
1800 F. G. N. Perrett—Self-regulating ballance blind pulley
1801 L. Sterne—Boring tools
1802 C. Stuart—Adjustsole wrenches
1803 H. K. York—Manufacture of steel
1804 H. G. B. Rober—Safety box slides
1805 J. Ward and F. Dressler—Easy chairs
1806 J. W. Cochran—Projectiles and cartridges for ordnance and firearms
1807 W. Clorke—Ornamental fabrics

Dated June 21st, 1867.

1808 J. W. Parkins—Stills for petroleum, &c.
1809 W. Robertson and C. J. Waddell—Improvements in apparatus
1810 H. Oram—Machines for sewing and stitching
1811 B. Browne—Folding bedsteads
1812 J. Gardner—Folding bedsteads and couches
1813 J. Powis and J. S. James—Tenon cutting machine
1814 W. Bellhouse—Furnaces for consuming smoke
1815 A. M. Clark—Measuring horses' feet
1816 F. C. Hemet and D. Spink—Raising and lowering weights
1817 B. Ford and T. Ford—Water tuyeres
1818 W. Price—Dies for stamping
1819 G. Dickie—Illuminating gas
1820 G. Simpson—Charging and emptying retorts
1821 F. Reddicliffe—Buckets for pumps
1822 E. McClintock—Motive power engines and pumps

Dated June 22nd, 1867.

1823 J. Onslow and F. Northall—Water tuyeres
1824 O. R. Chase—Combined feed water regulator and water gauge for steam boilers
1825 R. W. Morrell—Dyeing black
1826 A. M. Clark—Nippers
1827 S. Holman—Double action pumps
1828 T. Wilson and W. Hall—Raising and forcing fluids
1829 J. Surridge—Anchors for implements
1830 S. Hall and W. H. Parsons—Moulding artificial fuel
1831 J. L. V. le Marquis de Cosentino—Obtaining motive power

Dated June 24th, 1867.

1832 J. H. Kearns—Diary blotting pad
1833 J. Birch—Casting ingots of steel
1834 T. Rafferty and J. H. Storey—Moving, laying down, and jointing metal pipes
1835 E. Leahy—Cartridge cases
1836 J. K. Field—Candles
1837 E. P. Glesson—Cylindrical gas burners
1838 L. C. F. Clerc—Lamp burners for burning volatile liquids
1839 W. R. Newton—Governors for marine engines
1840 R. Cauper and G. Read—Ships' signal lights
1841 H. Rushton—Artificial hair
1842 H. R. J. Denton—Haymaking machines

Dated June 25th, 1867.

1843 T. Pehurdy—Surgical appendages
1844 J. Wilkinson and W. Grimshaw—Watches
1845 J. Webster—Metallic zinc paint
1846 T. Crow—Illuminating gas
1847 J. E. Whiting—Transmitting power
1848 F. Hook—Reefing and furling upper topsails
1849 A. Aitchison and T. South—Production of gas
1850 L. Brunetti—Embalming and preserving animal substances from decay
1851 W. T. Watts and D. J. Fleetwood—Hollow vessels
1852 J. Buckingham—Tool for opening metallic cases
1853 H. Veilon—Hot air ovens
1854 G. Alston—Consuming smoke in furnaces
1855 W. Cooke—Hoisting building materials

Dated June 26th, 1867.

1856 M. F. Maury—Protecting submarine cables
1857 T. Taylor—Playing games of skill and chance
1858 J. Hamnn—Breech loading cannon and firearms
1859 R. Eadie—Axles
1860 W. E. Newton—Filtering apparatus
1861 R. P. Forlong—Consuming smoke in furnaces
1862 W. B. Gray and S. G. Sinclair—Spinning and twisting machines
1863 W. R. Lake—Churns
1864 W. R. Lake—Cotton gins
1865 A. C. F. Franklin—Steam engines

Dated June 27th, 1867.

1866 E. Whele—Gauging and cutting soap
1867 J. G. Rowe—Railway signals, &c.
1868 W. E. Gedge—Raising running waters
1869 J. McEwen—Roll tobacco
1870 J. Gabbott—Wire healds
1871 W. Bullough—Looms for weaving
1872 J. Cash and J. Cash—Winding bands
1873 E. Farrington—Breech loading firearms, &c.
1874 C. E. Brooman—Regulating jupons
1875 W. E. Newton—Iced beverages
1876 M. H. Taylor—Tuyeres for smiths' hearths
1877 W. Hodgson—Screw gill boxes
1878 C. J. Pownall—Communicating intelligence between parts of railway trains
1879 W. R. Lake—Self detaching coupling for railway carriages
1880 W. R. Lake—Bands for securing bales of cotton, &c.
1881 J. R. Cooper—Breech loading firearms
1882 W. Davis—Fastening envelopes

Dated June 28th, 1867.

1883 L. B. Elliot—Mowing machine
1884 W. Marshall—Bedsteads, etc.
1885 J. H. Viton—Adjusting paper linings to the interior of casks, etc
1886 C. O. Heyl—Making sulphuret of carbon
1887 C. O. Heyl—Extracting fatty matters from and scouring wool, etc.
1888 J. C. Sellars—Utilisation of a certain waste material
1889 E. J. Hughes—Printing textile fabrics
1890 A. M. Clark—Presses for endorsing
1891 G. K. Geyelin—Folding wire netting
1892 C. Brown—Actuating motive power engines
1893 H. A. Lyman—Ladies' skirts
1894 J. G. Tongue—Adjustable wrenches
1895 J. Anderson and T. Anderson—Harness of jacquard engines
1896 J. Holroyd and W. Fieldhouse—Twisting machinery

Dated June 29th, 1867.

1897 C. O. Heyl—Extracting oil
1898 P. Zaroubine—Sucking and forcing hydro-pneumatic pump with no piston
1899 P. Smith—Securing the contents of bottles
1900 A. M. Fell—Purifying compounds
1901 A. M. Fell—Treating jute
1902 A. Hodge—Fixing door handles
1903 H. J. Cox—Carriage bodies
1904 S. Trulock, R. Trulock, and W. Trulock—Breech loading firearms
1905 W. H. Richardson—Iron and steel
1906 A. Stewart—Textile fabrics
1907 J. J. Lane—Making tapers
1908 C. C. Dubrulle—Miners' lamps
1909 Z. Coulong—Combs for warping, etc.
1910 C. Petit—Lamps
1911 E. Sephton—Workmen's dwellings
1912 E. Simmons—Screw propellers
1913 C. E. Brooman—Fixing metals on fabrics
1914 G. Rees—Treating glass

Dated July 1st, 1867.

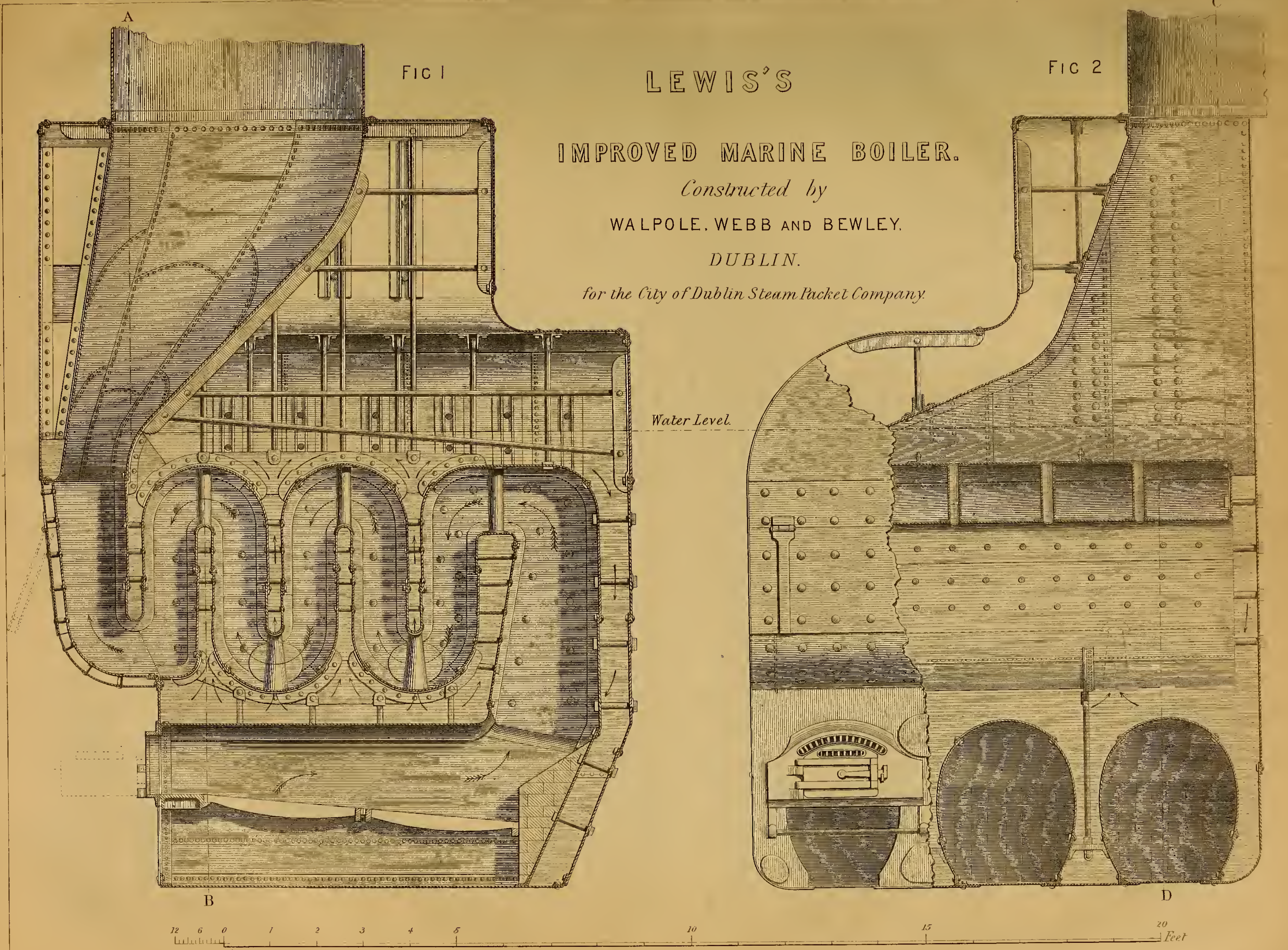
1915 J. G. N. Alleyne—Clocks
1916 J. Chaudron—Boring wells
1917 F. T. Hubert and H. D. G. Truscott—Electric telegraph machines
1918 F. T. Pollard—Bench hook
1919 P. Ironside—Venetian blinds

Dated July 2nd, 1867.

1920 J. B. Burn—Presses for cutting paper
1921 W. Duce—Stoppering bottles
1922 W. Steven and A. Robertson—Brick making machines
1923 J. Greenhalgh—Opening and cleaning fibrous materials
1924 G. A. F. Fowke—Compositions
1925 T. Wood and J. Wood—Printing hanks of yarn
1926 A. M. Clark—Breech loading ordnance
1927 J. Sturgeon—Getting coal
1928 A. Schwartz—Lubricators
1929 T. Young—Buttons for dress
1930 G. Gordon—Washing and drying, etc.

July 3rd, 1867.

1931 J. Somerville and R. Eldon—Purification of gas
1932 J. Elce and P. Williams—Spinning and doubling
1933 W. R. Lake—Cordage, etc.
1934 F. R. Aikman—Firearms and ordnance
1935 J. McKibbin—Filling into and drawing liquids from casks, etc
1936 H. Davey and D. Davey—Governing engines
1937 W. Galloway and G. Plant—Welded tubes
1938 D. P. Morison—Miners' safety lamps
1939 T. Borlase—Grinding and pulverising
1940 W. S. Scott and W. H. Steel—Self-acting escape
1941 R. Shaw—Motive power engines
1942 J. H. Johnson—Preserving butter



LEWIS'S

IMPROVED MARINE BOILER.

Constructed by

WALPOLE, WEBB AND BEWLEY.

DUBLIN.

for the City of Dublin Steam Packet Company.

W. Smith C.E. direx

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LEWIS'S IMPROVED MARINE BOILER.

As Constructed by Messrs. Walpole, Webb, and Bewley, Dublin.

(*Illustrated by Plate* 319.)

Ever since the first introduction of steam as a motive power, the means by which that power may be best obtained has commanded a very large share of the atteution both of engineers and of scientific men in general, as a natural consequence of the immense and growing importance of the object. The fruits of such combined and continuous study have been as varied and abundant as could be expected; almost every conceivable form of boiler has been tried, in many cases differing in appearance from one another, both inside and outside, as much as possible, yet all endeavouring to attain the same, or nearly the same, object. There are, of course, slightly different desiderata under different circumstances, such as, whether a boiler is required for land (fixed), locomotive or marine purposes; economy of fuel in the first, economy of weight and space in the second, and economy of fuel and space in the last of these cases being the principal necessities. There are also, of course, some peculiar cases where the general principle of economy does not hold good, as, for instance, in a steam fire-engine, or where the amount of available space necessitates the adoption of some particular shape of boiler adapted to the situation; but these only furnish sufficient exceptions to prove the rule. It is, perhaps, in marine boilers that the greatest amount of ingenuity and invention has been expended, and naturally so, for in this case economy of fuel and efficiency of working are of more importance than in either land or locomotive boilers. The necessity for durability is obvious, as, of course, no repairs to any extent can be performed except when in port; and if in a foreign one, not always then, while the frightful expense of such repairs is only too well known to steamship-owners. It is not always that the great advantages of economy in fuel are wholly realised, as it is not only the saving in the cost of the coals, which sometimes may not be of such great importance, but the addition to the carrying capacity of the vessel, and, consequently, to the amount earned upon the freight. Thus, suppose that by certain alterations in the machinery of a steamship, the vessel burns less coal by 100 tons to what it formerly burnt on its voyage, the saving would not only be the cost of the 100 tons of coals, but, in addition, the value of the freight of 100 tons of cargo for which space is thus afforded, virtually making the saving of each ton of coals worth, say £2 or £3, in addition to the absolute cost of putting them on board. There are also many other advantages to be derived from decreasing the consumption of fuel in steam vessels, such as the increased distance to which they are enabled to go, or a smaller vessel may be employed by which in many places a considerable sum may be saved in tonnage dues.

The early type of marine boiler was on the flue system. These boilers, so long as they were worked on the Cornish principle of slow combustion, performed very satisfactorily: in fact, it is well known, that a pair of marine boilers constructed by Messrs. Maudslay, Sons, and Field for the Blackwall Railway Company, were rather more economical than the Cornish boilers which were set alongside them, both being worked with the same coal and at the same pressure, and which may therefore be considered a fair trial. At that time slow combustion was considered essential to economy, as it was taken for granted that a rapid draught would carry the heated gases up the funnel without allowing time for them to part with a sufficient amount of caloric, but when the tubular system was introduced into marine boilers a more rapid combustion was found necessary. There are many enthusiastic supporters of both systems, and, of course, certain shaped boilers are especially suited for the one or the other. At one time it was thought that the tubular boiler would supersede all others for marine purposes, and no doubt it did so to a great extent, but there were several strong objections advanced by practical men which deserved serious consideration, especially when the vessels fitted with such boilers were destined for long voyages, or were employed where the water was very salt. Of these objections the strongest were three in number, firstly, the difficulty or impossibility of keeping the tubes free from scale, or of scaling the tubes when covered with hard deposit; secondly, the liability of a few out of such a great number of tubes to leak; and thirdly, the trouble and loss in having to sweep out the tubes every few days, besides which, it may be added, that in cases of carelessness or neglect the tubes have been known to "salt up" into a solid mass. The first of these objections is no doubt a very serious one, as the coating of deposit on the tubes, as is well known, vitiates the heating surface to an enormous extent, so that the very large tube surface is not nearly so practically effective as it should be according to theory.

Again, as a natural result of this deposit the tubes get overheated, expand, and leak at the tube plates, and when once this begins to any extent there is no more peace for the engineer, for most probably if he succeeds in caulking the faulty tubes he will start some of the others which before were sound. It is in consequence of these defects in tubular boilers for marine purposes that various inventions have been made for the purpose of superseding tubes altogether, and in Plate 319 two views are shewn of Lewis's marine boiler, which have, in practice, proved very successful. One of these boilers was made by Messrs. Walpole, Webb, and Bewley, of Dublin, for the steamer *Shark*, and after regular running for seven months, during which time the boiler was never cleaned, it was examined and very little scale had accumulated. The same engineers are now building a steamer in which it is intended to give the system a more extensive trial with larger boilers, in one of the City of Dublin Steam Packet Company's new ships, by making the two forward boilers tubular and the two boilers aft upon Lewis's system: the shells and grate surfaces of each to be exactly the same size in every respect.

The following is the result of some experiments made in order to determine the evaporative power of the boiler with various descriptions of coal:—

Description of Coals.	Pounds of water evaporated by 1lb. of coals from 212°.	Pounds of coals consumed per ft. of grate surface per hour.	Cubic ft. of water evaporated per sq. ft. of grate surface pr. hour from 212°.	
	lbs.	lbs.	cub. ft.	
Little Mountain, N. Wales	12·08	20·09	3·86	Swift coals, rather dirty.
Glasgow Steam.........	13·38	13·17	2·82	Good strong coals, last well.
Powell's (Dufferin) ...	10·03	17·56	2·82	Burnt very swift, with a very short flame.

It will be seen from the drawings, (Plate 319) that externally, and with the exception of that part of the boiler usually occupied by the tubes, there is no difference between this and the ordinary tubular boiler. Instead of the tube space, an undulating flue is constructed the whole width of the

boiler (with the exception of a waterspace between the shell and the flue) causing the heated gases to travel in a circuitous course, shewn by the arrows in Fig. 1, thereby affording a large amount of effective heating surface and enabling it, as shewn above, to evaporate as much as 13lbs. of water to 1lb. of coal.

Upon referring to Fig. 1 of the plate, it will be seen that the heated products of combustion impinge directly upon flat unbroken surfaces, nearly the whole of which may be calculated as effective heating surface, while from their position they are not liable to be readily deteriorated or unequally worn by the action of the heat, or by the accumulation of deposit. Holes somewhat similar to man-holes are made at the side of the boiler, by which means access to the flue may be obtained at any time for the purpose of cleaning or repairing, though in practice these would probably never require to be used during a voyage, as it has been ascertained after a trip of a fortnight duration, that, so complete was the combustion there was not more than a quarter of an inch of deposit on the bottom of the flue. In some cases entrances to the flue are provided for, by means of openings in the crown of the furnace, over which are fitted plates to prevent the flame passing through when at work, and which, on arriving at the end of the voyage can be easily removed for the purpose of cleaning or repairing the flue. To the holes at the side, mentioned above, plates of mica may be fitted instead of plates of iron, by which means the state of the flue may always be inspected without it being necessary to slacken the fire, thereby saving any unnecessary stoppages for cleaning out, or enabling the engineer at once to discover a leak—a not unimportant consideration in ocean-going steamers.

Tubes connect the water spaces at the top and bottom. It was at first considered by some engineers that the narrow dependant water spaces at each bend of the flue would salt up, but after a thorough trial it has been found that such is not the case, the rapid circulation of the water in those parts effectually preventing the slightest deposit.

One advantage of this boiler is that being, as we said before, precisely similar in external shape to a tubular boiler, it can, of course, be fitted into a vessel in the place of the latter without any alterations; or what in many cases might be much more economical, the shell and furnaces of the boiler might be retained, the tubular portion only being replaced by the undulating flue.

It is satisfactory to know that the results of a series of well-conducted experiments under the supervision of careful inspectors, were considered so conclusive, that the Directors of the City of Dublin Steam Packet Company determined to adopt these boilers on board of their newest steamship, the two forward boilers being of the best type of tubular boiler, and the two after boilers are to be supplied by Messrs. Walpole, Webb, and Bewley, on Lewis's plan, thus affording an excellent opportunity for proving the superiority of Lewis's boiler over the best example of modern tubular boilers.

It is worthy of observation that the managing directors of the City of Dublin Steam Packet Company have always been foremost in introducing improvements connected with the economic development of steam navigation, and the late Mr. Charles Wye Williams, who was one of the original projectors of the company, and one of its managing directors up to the time of his death, attained a world-wide reputation as a scientific experimentalist and writer upon the generation of steam and the economic combustion of coal in steam boilers. His coadjutor, Mr. W. Watson, is likewise known extensively for the great interest he has taken in the same subjects, and for the great experience he has had in steam navigation; and the Committee on Steam Ship performance, which for several years was annually appointed by the British Association for the Advancement of Science, were indebted to Mr. Watson for many of the interesting facts and results of experiments published by them in their annual reports relating to the performances of the steamships belonging to the City of Dublin Steamship Company, and particularly of the four celebrated Holyhead mail-packets.

REPORT ON RAILWAY APPARATUS, CLASS 63, IN THE PARIS EXHIBITION.

By Sir D. CAMPBELL, Bart.

(*Continued from page 174.*)

No. 28 is a model of electric apparatus, by M. Prondhomme, for communication between passengers and guard. The couplings consist of short lengths of insulated wires attached to galvanised rings, which are hooked on to bronze spring hooks at the end of each carriage. These hooks have insulated wires connecting them under the frames of the carriages. This system is extensively adopted in France, and especially on the Chemin de Fer du Nord. A perfect coupling is, however, yet to be discovered, as a large percentage of attempted signals fail.

No. 32. M. Vivaux and Co. exhibit under this number a quantity of beautifully sharp and clean castings of cylinders and grease-boxes; also an axle-box with apparatus for using water instead of grease. It consists of a disc at the end of the axle with projections on it, which catch up the water in revolving and make it pass over the axle.

No. 34. Messrs. Arbel-Deflassieux and Co. exhibit some excellent wrought-iron stamped railway wheels, made by their process, which consists in putting the pieces of the wheels together cold in a matrix. They are then raised to a welding heat, and by means of a superimposed die and a 24-ton steam-hammer are stamped into one piece. These wheels have a great reputation in France, where they are extensively used. A number of drawings and models of articulated or bogie-frame engines are exhibited. No. 13, by M. Thouvenot, is a drawing of a double engine, with four cylinders, intended for the passage of the Alps, and is somewhat similar to that of Mr. Fairlie. There is attached to it a modification, intended for a line with a central rail, on the Mount Cenis system.

No. 24 is a model by M. Gouin, in conjunction with M. Boutmy, of an articulated engine with ten coupled wheels on two bogie-frames. The front one carries the engine, and has six coupled wheels; the hinder one carries the tender, and has four coupled wheels. Between the latter is an independent axle, worked by a connecting-rod from the driving-wheel. The crank-arms of this axle work in a slot in the coupling-rods of the four trailing-wheels, and communicate the motion to them while admitting any amount of lateral play.

No. 42 is a first-class carriage exhibited by the Eastern of France Railway Company. It has two ordinary compartments, with eight places in each, and a deep coupé with three places in it. The backs of the seats in the coupé are made to fold down forwards, forming beds, with comfortable mattresses on them, and the additional space afforded by the recesses into which these beds fit give ample room to recline at full length. The amount charged for these "coupé lits" is 40 to 50 per cent. higher than the ordinary first-class fare. It is greatly to be desired that a similar system should be introduced into England for the night mail-trains. The ordinary comparts have an arm in the centre of each seat which folds up out of the way, so that passengers may recline in them if there be room. This carriage is very well finished and is most comfortable, but has one serious drawback, which is the total absence of ventilators; and the sides of the doors are, moreover, provided with strips of indiarubber, more effectually to exclude the external atmosphere. The reason assigned for this is, that, owing to the numerous disputes among the travellers as to the use of the ventilators above the doors, the company have determined to settle the question by dispensing with them, thus leaving the ventilation to be managed by lowering the windows. Whether this mode will tend to promote greater harmony among travellers is more than doubtful.

No. 41 is a double-storied carriage exhibited by the same company, and principally intended for suburban traffic, where the speed of the trains is not great; but this type of carriage is also destined for the conveyance of excursionists from Strasbourg to the Paris Exhibition. The lower story contains a first-class compartment for eight passengers; two second-class compartments, carrying twenty passengers, and a third-class compartment for women, holding ten passengers. The upper story, which is reached by an iron stair, with light iron hand-railing at each end, has a passage down the centre, with ten seats for two persons on each side. The second-class compartments are very comfortably fitted up with plain, well-stuffed cushions and backs, and have hat-nets over the seats. The third-class compartments are also comfortable, having curved seats and backs, though without cushions; they are well glazed, and have curtains to the windows. The lighting, however, is poor, and there are no ventilators. In order to keep the centre of gravity as low as possible, the two stories are each made only 5t. 5in. in the centre, and the heat, especially in summer, must be intense in them. The oscillation with a heavy top load must be very great, and they cannot be safe carriages to run at a high speed.

The longitudinal bearers of the frame are of iron, and are curved upwards and outwards at the ends to receive the buffer-boards, which are fitted with horizontal springs, the ends receiving the buffers, and the centre being coupled to the draw bar. The transverse bearers at the ends are of iron, and the intermediate ones of wood. The wheels come up through the floor under the seats, the divisions of the compartments corresponding exactly with the centre of each of the two pairs of wheels. The cost of this carriage is about £410.

No. 49 is a somewhat similar double-storied composite carriage, built for M. Vidard by Gargan and Co., holding eight first-class, ten second-class, and thirty-six third-class passengers. It is provided with a brake, weighs $5\frac{3}{4}$ tons, and costs about £320.

The above comprise the principal objects exhibited by France within the building.

The *annexe* in the park is specially devoted to railway carriages, and the various articles employed in their construction and fittings.

M. Bonnefond and Co., exhibit, under the numbers 132 and 138, a second-class carriage for the Eastern of France Railway, and a third-class carriage for the Paris and Orleans Railway; the former a good plain carriage, but deficient

in ventilation; the latter is also comfortable and well constructed, and has not the above defect.

Delettrez and Co. exhibit No. 140, a very good third-class carriage for the Eastern of France Railway, with curved seats, and backs, and partitions between the passengers, but having the defect of want of ventilation common to all the carriages made for this railway. They also exhibit No. 139, an excellent wooden-framed second-class carriage for the Western of France Railway, with most comfortably stuffed seats and backs. The wheels are solid, and have brakes on all of them.

Chevalier, Cheilns, and Co. exhibit No. 137, a good iron-framed, first-class, six-wheeled carriage for the Paris, Lyons, and Mediterranean Railway. It has three compartments and a coupé. The central arms in the seats fold up. The bottom is covered with sheet iron, the panels on the sides and ends with Bessemer steel, and the roof with sheet copper, to prevent fire. The weight is nine tons, and the cost of it £465. It is provided with a pneumatic apparatus for communicating between passengers and guard, which consists of a bell rung by means of a weight and pulley, working over a drum with cogwheels attached. The weight is kept in a state of rest by means of a detent, which is liberated by the withdrawal of the projecting end of the piston of a small cylinder. This cylinder communicates by means of flexible tubes with small air-pumps in the different compartments. On working these a partial vacuum is created behind the piston, which is then moved forward in the cylinder by the pressure of the external atmosphere. The detent is thus liberated, and the weight descending causes the bell to ring. The same firm also exhibit a very well-built travelling post-office of the French official pattern. It is unprovided with any machinery for giving or receiving the mail-bags when in motion; the stools and chairs are not fixtures, as in the English travelling post-office; and it is warmed by a stove with the pipe passing through the roof, which would aggravate the the results of a collision; and the edges of the desks and other projections are not protected by stuffing. These defects might easily be remedied: it is in other respects a very good carriage.

No. 135 is an earth-waggon, by Suc-Chanvin and Co., turning on a central pivot, and being thus enabled to tip on all four sides. It has a complicated system of levers to open the tailboard, which has, moreover, the defect of being hinged on the top, and altogether seems easily put out of order.

Messrs. Chatel, Luchaire, and Masson exhibit specimens of the different railway lamps in use in France, which do not present any very remarkable feature.

In the open space in the park M. Vignier exhibits his system for locking signals and points, which consists of a series of bolts moved by bell-crank levers, and fitting respectively into holes in the levers for working the points and signals. They are so adjusted that the act of working the lever of one signal moves the requisite bolts into the apertures made for the purpose in the levers of all the other signals which might occasion danger, and locks them. This system is very simple and effective, and was introduced into France by M. Vignier thirteen years ago. From all the bolts being placed in a horizontal plane, it takes up a good deal of space.

There are here exhibited also specimens of all the signals in use on the French railways The majority of them being disc signals.

No. 110 is a good self-acting distant signal by Dietrich and Co. It is put on by a passing train, and is worked by means of the circular arm of a lever which comes up beside the rail, and is placed in such a position that the flange of the first wheel passing over it depresses it, liberating the catch of a counterpoise, which puts on the signal, and, by means of a wire, gives intimation to the signal-man at the station that the signal is on. The signal can be reset by a second wire from the station.

M. Brame exhibits a signal worked in a similar manner by the train itself, but the signal is given by means of electricity instead of by a counterpoise.

No. 93 is a 39-ft. engine turn-table, exhibited by the Paris, Lyons, and Mediterranean Railway Company. It can be moved either by hand or by a small donkey-engine upon it. It works on four sets of large rollers, three in each set, with compensating levers.

No. 96 is a good articulated truck by M. Vidard, built at the works of Gargan and Co. It is capable of carrying a load of 16 tons, and is intended for the conveyance of timber, rails, and other lengthy goods on lines with sharp curves. It weighs only $6\frac{1}{2}$ tons when empty; and, its load being 16 tons, M. Vidard claims a great economy in tractive power for this description of waggon with any kind of goods.

M. Tricotel shows here a fruit-tree hedge, having wooden standards, with a lattice-work of laths between them, and three horizontal wires, along which the fruit-trees are trained. M. Tricotel asserts that it can be erected at a total cost of 11d. per lineal yard. Although it might possibly suffice for those portions of France where no cattle are allowed to go at large without a herd, and though it would probably be highly appreciated by the plate-layers on the railways, it is not of so substantial a character as to fulfil the requirements of the Board of Trade in England.

The next country in the catalogue is Holland, and the objects exhibited by it consist chiefly of railway carriages. The State Railway Company exhibits a composite carriage, with three second-class compartments, and a first-class coupé at each end. The coupés and one second-class compartment are for the use of smokers. It is very comfortably fitted up, and has small windows in the partitions, with a blind on each side. These are no doubt intended as a sort of protection for travellers, but are a more probable source of annoyance than of security. The frame has iron longitudinal and wooden cross bearers. They also exhibit a very good iron guard's van, with sliding doors. At the end of the van a seat for the guard is placed on each side, with the brake-handle between them. In front of each of these seats there is a window, and also projecting windows above and at the side, with mirrors so disposed that, without moving from his seat, the guard can see behind the train, and also the tops and sides of the carriages, while at the same time the brake-handle is at his elbow.

M. Beignes exhibits an excellent composite carriage, with two first and two second class compartments, which are lofty and well ventilated. The first class compartments are well fitted up, and the only fault of those of the second class is that they are so comfortable as to render the first class superfluous.

Next in order is Belgium, whose "exhibits" are distributed among two annexes and an open space in the park, and rank next in importance to that of France.

The Compagnie Belge exhibit a locomotive, with six coupled wheels, for the Luxemburg Railway, having inside cylinders and outside bearings. The eccentric rods are very short, and thereby have to work at a sharp angle. It weighs 36 tons when loaded, and $31\frac{1}{2}$ tons when empty, and is a plain, good engine.

They also exhibit an excellent iron covered goods-waggon, on four cast iron wheels, with axle boxes on Gobart's system, It has a door and communicating platform at each end, and four vertically-sliding ventilating windows in each side, the openings of which are protected by gratings. It has a wooden floor, and E iron at the joints of all the iron plates. It is fitted with spiral draw springs for the central and side chains, weighs $6\frac{3}{4}$ tons, carries a load of 10 tons, and costs £192. The same company exhibits a composite carriage, which is the most perfect in the Exhibition. It has a first, second, and third class compartment, and also a first class coupé, which is fitted up with morocco leather. The second class compartment has open canework seats and back. The steps are of metal, and are roughened to prevent slipping. The doors are provided with slips of india rubber round the joints to keep out draughts. The compartments are lofty and well lighted, and have ventilators round the lamps and over the doors. The frame is of iron. The carriage weighs 9 tons, holds thirty-two passengers, and costs £600.

The Société St. Léonard exhibit a ten-wheeled tank-engine for the goods traffic on the Santander Railway. It is calculated to take a load of 200 tons up gradients of 1 in 50, and round curves of less than 15 chains radius. The six hind wheels are coupled, and the four front wheels are on a bogie frame. The bogie frame is connected with the engine by means of a pivot working with a spherical universal joint in the centre of the frame, and having fixed to the top of it a horizontal lever, the other extremity of which is articulated to a fixed point below the boiler. The smoke-box is carried on the pivot end of the lever by two cast-steel wedges, which ride on double inclined planes on top of the lever above the pivot, By means of the rotation on the pivot and the lateral play on the inclined planes, the axles of the bogie are kept parallel to the radius of the curves and its centre in the axis of the line of rails. The trailing-wheels have also 9-16in. of lateral play. The cylinders are outside and placed at an angle of 16deg. The valve gear is worked by Walschaert's system of link motion —that is, by a single eccentric and by a series of levers from the crosshead of the piston. This plan is stated by the Belgian engineers to work well: but it looks very complicated, and as if very little wear would occasion loss of lead. The drawbar has lateral play, working in a slot in the buffer board, and is led under the axle of the driving-wheels to the centre of the engine, where it is articulated. The tank overhangs, and is parallel to and below the level of, the top of the boiler. The principal dimensions are—Area of fire-grate, $28\frac{1}{2}$ft. square; number of tubes, 200; length of tubes, 13ft. $6\frac{1}{4}$in.; diameter of tubes, 2in.; diameter of boiler, 4ft. 3 3-16in.; total heating surface, 1,490 square feet; diameter of cylinders, $18\frac{1}{8}$in.; stroke, 24in.; diameter of coupled wheels, 3ft. $11\frac{1}{4}$in.; weight, when loaded, $44\frac{1}{4}$ tons; when empty, $35\frac{1}{2}$ tons.

The Couillot Company exhibit a tank-engine for working coal traffic up steep gradients and on sharp curves. It has four wheels, which are coupled to an intermediate axle, driven by connecting-rods from the pistons. The fire-box is on Belpaire's system for burning small coals. The cylinders are inside and inclined, and the valve gear is on Walschaert's system. It is provided with a steel slipper brake, which works on the rails; and it weighs 23 tons when loaded, and 19 tons when empty.

Cockerill and Co. exhibit a six-wheeled express-engine, made at their works in less than three months. The four hind wheels are coupled. It has a Belpaire fire-box, screw reversing gear, inside cylinders, outside bearings for all the wheels, and additional inside bearings for the driving-wheels, wrought-iron boiler and Bessemer steel tires. The springs of the coupled wheels have compensating levers. Every part of the engine, including steel tires and plates, was made in Messrs. Cockerill's works, and it is a good, strong, and serviceable piece of work.

M. Haeck shows an axle-box for lubricating carriage-axles with oil, water, and tallow. The apparatus consists of a small friction-wheel, which is pressed against the axle by a spiral spring within the box, the lower part of which is filled with tallow, oil, and water. The friction-wheel, in revolving, sends the oil and water over the axle; and if the heat becomes excessive the tallow is melted and comes into play as a lubricant, solidifying again when the temperature becomes lowered.

The Société d'Ougrée exhibit some very good specimens of wheels, axles, and tires. The Clabecq Ironworks send specimens of boiler-plates and locomotive frames; and M. Blondieaux exhibits samples of the different rails used in Belgium. All the latter class of "exhibits" have been treated in the English section as manufactured iron, and have been shown in class 40.

The principal objects exhibited by Prussia and the North German States are—

No. 1. A very well-finished, plain, and serviceable six-wheeled locomotive, by Borsig, of Berlin. The four hind wheels are coupled, and the springs have compensating levers. The cylinders and bearings are outside. The tender has six wheels and compensating levers, with brake-blocks on both sides of all the wheels. The principal dimensions are—Area of fire-grate, $18\frac{1}{2}$ft. square; number of tubes, 194; length of tubes, 11ft. 4in.; diameter of tubes, $1\frac{3}{4}$in.; total heating surface, 1,000ft. square; diameter of boiler, 4ft. 4in.; diameter of coupled

wheels, 5ft.; wheel base, 13ft. 4⅝in.; diameter of cylinders, 16in.; stroke, 22in.; weight, when loaded, 31¾ tons; when empty, 30½ tons.

No. 2 is a six-wheeled express-engine, by Hartmann, of Chemnitz, in Saxony. The four hind wheels are 6ft. in diameter, and are coupled, the trailing-wheels projecting above the footplate. The buffer-board turns vertically on a central pivot, to allow the pistons to be examined. M. Hartmann also exhibits a portable machine, invented by Elnhardt, for weighing separately the wheels of engines and carriages. It consists of a short lever, with the fulcrum resting on the rail itself, and capable of modification, so as to suit any section of rail. The weight is ascertained by means of a long steelyard with graduated scale and shifting weights. For carriages a smaller head weight and a second scale, marked on the steelyard, are used. It is a very handy little instrument, and gives the weight on the wheel of an engine to within 20lb.

The Company for the Manufacture of Railway Material at Berlin exhibit two composite passenger-carriages for the Stettin and Halle-Cassel railways, with retiring-rooms and conveniences for invalid travellers. They have no ventilators, and are warmed by means of boxes of hot sand, which are placed under the seats from the exterior. The second-class fittings are very good. They also exhibit a travelling railway post-office, with apparatus for taking up the mail-bags without stopping. The internal arrangements are not well designed; the counterpoise for the net projects awkwardly into the exterior, and there are several other projections unprotected by stuffing. It is warmed by a stove which is fed from the roof of the carriage.

Lüders, of Goerlitz, exhibits a composite carriage, with two compartments for smoking in, and a ladies' second-class compartment, which is fitted up more handsomely than the first class. There is no provision for ventilation.

Several goods and coal waggons are exhibited, the best of which is an iron waggon, by Schmidt and Co., of Breslau, for a Polish railway. It weighs 5 tons, and carries a load of 10½ tons.

The Bochum Ironworks exhibit a magnificent specimen of casting in steel, which consists of twenty-two railway-carriage wheels cast in one piece.

The Eastern Railway Company exhibit an apparatus for indicating the regularity of speed or of tractive force used between stations. It consists of a dynamometer worked by levers instead of springs, which is attached to the drawbar of the tender, and indicates the strain on it by means of a pencil-point on a revolving strip of paper.

The Grand Duchy of Baden is represented by a locomotive from the Carlsruhe works. It has six coupled wheels, outside cylinders, and inside valve gear. The slide-valve spindle is curved over the axle of the leading wheels. The connecting-rods are very light, but the workmanship of the engine is good.

From Wurtemberg M. Kessler exhibits a six-wheeled locomotive, made at Esslingen, for the East India Railway Company. It is built from English drawings and the workmanship is excellent. The four hind wheels are coupled; the frame is inside, and straight from end to end; the cylinders are outside; the tires are of steel and are bolted between each spoke. It is provided with screw-reversing gear, and has a large awning.

Bavaria is represented by M. Krauss, who exhibits a four-wheeled tank-engine with the tank under the boiler and forming the frame. The cylinders are outside, and the valve gear is overhanging. This is the first engine built at M. Krauss's works, and hence there is room for improvement in the workmanship.

In the Austrian section the exhibition is largely composed of specimens of rails, wheels, tires, and axles, in steel and Styrian iron, the quality of which is excellent. M. Sigl, of Vienna, sends a six-wheeled locomotive for a railway at Warsaw. The four hind wheels are coupled, and have compensating levers. The cylinders are outside, and also the bearings, which are made on Hall's system, with the cranks let on to the axles. The slide-valve spindles have no guides, on Sharpe Stewart's plan. The workmanship and general plan of the engine is good. He also exhibits an engine with eight coupled wheels for a Russian railway of the 5ft. gauge. It is intended to burn wood, and has a funnel-shaped chimney. The valve gear is very overhanging.

The State Railway Company exhibit "the Steierdorff," a ten-wheeled engine, which was exhibited in London in 1862, and has worked satisfactorily since then, with a slight modification in the tender. It was designed for the coal traffic on the railway from Oravicza to Steierdorff, on which there is a gradient, ten miles in length, of 1 in 50, with numerous 5½-chain curves; and the rail only weighs 52lb. to the yard. The engine is carried on two bogie-frames, the leading one having six coupled wheels and the hind one four coupled wheels, and an intermediate axle coupled to the driving-wheels on the leading bogie-frame, and communicating the motion to the trailing-wheels by means of a short vertical connecting-rod, with universal joints, to admit of the lateral play. The bogie-frames are connected with each other by a spherical universal joint. The smoke-box is fixed to the leading bogie-frame, and the boiler is supported by three other cross-frames on it. The fire-box rides on a roller on the hind bogie, which supports it while allowing it to move laterally. The fuel is carried in bunkers on the hind bogie, but the water is now placed in a guard's van behind the engine, fitted with a tank for the purpose. This van is also articulated to the engine by a spherical universal joint, and is provided with a powerful brake, which can be reached by the stoker from the engine. The engine is also provided with a brake on the four hind wheels of the leading bogie, which is worked by steam, and has cylinders for the purpose under the engine. The principal dimensions are:—Area of fire-grate, 15 square feet; number of tubes, 158; length of tubes, 11ft. 6½in.; diameter of tubes, 2in.; total heating surface, 1,321 square feet; diameter of boiler, 4ft.; diameter of cylinders, 18 3-16in.; stroke, 24½in.; diameter of wheels, 3ft. 3⅜in.; wheel base of both bogies and of guard's van, 7ft. 3in. each. Weight when loaded—engine, 41¾ tons; guard's van, with water, 15 tons. The coupling-rods work very close to the ground.

M. Bender exhibits an arrow-headed signal, which indicates the direction for which the points are open. The arrow head is coloured red and whites and is illuminated at night by a lamp, with reflecting mirrors on the outside. Its sides are curved, so as to reflect the rays back from the mirror, in parallel lines, and to prevent the colours being confused at a distance, so that the day signal and the night signal are identical.

M. Ganz shows a sample of chilled cast-iron crossings, which are largely used in Austria, and some chilled wheels, one of which is exhibited to show the effect upon it of thirteen years' constant wear. The metal is very good.

The Southern Railway Company exhibit some specimens of steel tires and axles, and of rails twisted when cold, made of Styrian iron alone, and also with Bessemer steel tops, and some of Bessemer steel altogether.

The specimens of iron and steel work sent by Henkel, of Donnersmark; the Neuberg Ironworks, and Prince Lichtenstein; and the steel springs by Mayer and the Eibinvald Ironworks are well worthy of inspection; and, in general, the quality of the materials of this description exhibited by Austria is very good.

Switzerland is represented by the Société Industrielle de Neuhausen, which exhibits a light carriage in two compartments, for second and third-class passengers, with a platform at each end and a central passage throughout. It is comfortably fitted up; but the above arrangement has the disadvantage of involving a waste of seat space. This carriage is to be found in an annexe in the park.

Sweden has three representatives, of whom the principal is Zethelius, of Westerås-Surahammar, who exhibits some good wheels, axles, and tires.

In the Russian section there are some good cast-steel axles, which are made from Siberian iron, and are sent from the Oboukoff Steelworks.

M. Schoubersky exhibits, in the park, a model on a large scale, showing the working of the Makhovoz system of locomotion on steep inclines from mines. The apparatus consists of a truck fitted with a pair of 15-ton flywheels on an axle carried on friction-rollers, which themselves rest on the wheels of the truck. Each train of loaded waggons has one of these trucks attached, and is impelled down the incline by its own weight, and the truck wheels in revolving transmit a rotatory motion to the flywheels by means of the friction rollers. On reaching the bottom of the descent the rollers are lifted, by means of levers, clear of the truck wheels, and then revolve freely, opposing hardly any resistance to the action of the flywheels. The truck is then detached, turned round on a turn-table, and attached to the head of a train of empty waggons. The friction rollers are then let down on to the truck wheels, transmitting to them the rotatory power stored up in the flywheels, which M. Schoubersky considers sufficient to take the empty waggons to the top of the incline. It does not appear, however, to be a very safe or certain mode of locomotion and it would be necessary to have in reserve some extraneous assistance in the event of its coming to a standstill, from any cause, before reaching the summit.

The Italian exhibition in this class is not very important, the principal objects being some grease boxes, by Benech-Rochetti, and a covered goods-waggon and some small locomotive fittings from the Roman Railway Company.

In the United States section, which is placed in an annexe in the park, the principal object is a locomotive and tender, built by Grant, of Patterson, New Jersey. This, from the peculiarity of its construction and the florid style of its ornamentation, is a complete contrast to the other engines exhibited, and is very interesting as being a type of those used on the other side of the Atlantic. It has eight wheels, the four leading ones being on a bogie, and being made of hollow cast-iron with hollow spokes. The four hind wheels are coupled and have compensating levers to the springs. The cylinders are outside, and the slide-valves work on anti-friction rollers running on tempered steel plates. The frame is made very light, in order to give it elasticity to meet the inequalities of the road, which is not generally constructed in America in the level and solid manner which is customary in Europe. The weight is also distributed with a view to the imperfection of the roadway, there being only 7½ tons on the bogie wheels and 20 tons on the four coupled wheels. In front of the bogie frame is placed the cowcatcher, a sloping grating, made so as to throw off any obstruction to one or other side of the road. Above this, and in front of the top of the smoke-box, is placed an enormous lamp, or "head-light," with powerful parabolic silvered reflectors, the object of which is not to give warning of the approach of the train, but to enable the engine-driver to descry at a distance any obstruction there may be on the line of rails—a precaution which is very necessary on the unfenced railways in America. A large bell is suspended on top of the boiler, with a cord carried back within reach of the engine-driver. The footplate is

covered by a very handsome "cab," made of inlaid wood and comfortably fitted up. The handles of the various cocks are made of ivory, and the covering of the boiler, cylinders, and chimney are of polished brass and German silver. No doubt, much of this extra ornamentation is due to the fact of the engine being intended for the Exhibition; but it is stated by Mr. Grant that the American engine-drivers require a greater amount of outward show in their engines than is thought necessary in this country. Above the fire-door are fixed a clock and four cocks for lubricating the cylinders, two of them admitting the oil into the lubricators, and the other two admitting jets of steam, which drive the oil to the cylinders. The fire-bars are hollow and form part of the heating surface, and are said to wear well with the American coal. The tender weighs 9 tons when empty and 18 tons when loaded, and has eight wheels, on two bogie frames. The brake is on the wheels of the hinder bogie.

In the English section, although in individual cases the "exhibits" are unsurpassed, if not unequalled, the Exhibition, as a whole, does not come up to the standard of what might have been expected, either in numbers or in importanee of the objects exhibited. In it there are neither goods-engines, railway-carriages, vans, nor goods-trucks; nor, with the exception of some steel springs, are there any specimens of the various locomotive and carriage fittings which are exhibited in such numbers by other nations. None of the English railway companies have followed the example set them by those on the Continent in contributing to the display made by their respective countries.

Stephenson and Co. exhibit a beautifully-finished six-wheeled express passenger-engine, built for the Pacha of Egypt. It has inside cylinders, single driving-wheels, and a straight double frame. The boiler-casing is removed on one side, to show the construction of the boiler, which is made of wrought iron, the longitudinal joints being welded so as to form complete rings. The plates are thickened at the transverse butt-joints to allow for the loss of strength in the rivet-holes, and they are double riveted, with outside covering strips. The reversing gear is worked by a screw and also by a hand lever, through an opening in which the screw passes. The hand lever has a sliding catch which can be let down into the thread of the screw, thereby putting the latter into gear. The screw has a curved tapering form, the upper surface following the are of a circle having its centre at the fulcrum of the lever. For excellence of workmanship, simplicity of design, and chasteness of finish it stands unrivalled in the Exhibition. The principal dimensions are—area of fire-grate, 14 square feet; number of tubes, 161; length of tubes, 11ft. 4in.; diameter of tubes, 2in.; total heating surface, 1,038 square feet; diameter of cylinders, 16in.; stroke, 22in.; wheel base, 15ft. 8in.; diameter of driving-wheels, 6ft. 6in.; weight when loaded, 30 tons, of which $13\frac{1}{2}$ tons are on the driving-wheels, but can be varied, if necessary, by adjusting screws to the springs; weight when empty, 27 tons.

Next to this is a six-wheeled locomotive, by Kitson and Co., for mixed traffic, the workmanship and design of which are also excellent. The four hind wheels are coupled, and are 5ft. 6in. in diameter. The cylinders and bearings of coupled wheels are inside, the leading wheels having outside bearings. The boiler is constructed in the same manner as that of Stephenson's engine. The coupling and piston rods and the tires are of steel. The sand-box is worked from the foot-plate by means of a treadle.

The Lilleshall Company also exhibit a very creditable express-engine, and as it is one of the first produced in the works of this company, it gives good promise for the future.

Messrs. Ruston and Proctor and Messrs. Hughes and Co. exhibit each a contractor's tank-engine. The former firm have adopted Clark's smoke-consuming apparatus, and have fitted the injector directly on to the barrel of the boiler, and have largely introduced steel in the motion works.

Messrs. Saxby and Farmer exhibit a very complete and well-executed working model of their system of locking points and signals, so as to prevent conflicting signals being given, and thus avoid the possibility of an accident at a junction if the signals be obeyed. The model in question is that of a double junction, with a through crossing on the main line in front of the meeting-points. The levers for the main and distant signals and for the points themselves are brought together into a raised signal-box on one side of the railway. A similar arrangement is employed at the Cannon-street and Charing-cross stations in London, where an enormous number of point and signal levers are concentrated into a very small space.

Pooley and Son exhibit a railway weigh-bridge, which has the advantage of admitting repairs and adjustments to be effected without disturbing the road. To secure this the levers are built into the masonry at the sides of the pit, with access from the top by means of a moveable iron plate. The necessity of introducing a relieving or locking apparatus is dispensed with by hanging the bridge on to the projecting arms above the knife-edges by means of chain links, which take the oscillation and prevent any lateral motion in the knife-edges.

Turton and Sons and Spencer and Sons exhibit some excellent specimens of steel railway springs.

Mr. Preece shows some models of electric repeating signals, by which the signal given is repeated back to the operator, thus preventing mistakes. The system is not entirely new; but has been modified and improved by Mr. Preece.

Miss Gordon exhibits an ingenious system of electric communication between passengers and guards. The commutator is connected with handles in the compartments, and on pulling them a disc signal is displayed from the side of the carriage, and a bell is rung in the guard's van. The electric coupling between the carriages is very simple, and easily managed. It consists of two wooden frames, in which are placed a set of curved metal springs, projecting slightly above the surface of the frames. These springs are connected with the conducting wires of the carriages. The frames have also a catch spring at each end. The connection is effected in an instant by sliding one frame over the other, when the curved springs are brought into contact with each other, and are thus kept in position by the catch springs.

A good system of locking the levers of signals and points is exhibited by Messrs. Livesey and Edwards. It consists of a series of iron rings at the end of bell-crank levers, so arranged that, on pulling over the lever of one signal, these rings come down over the handles of all the other levers, by which conflicting signals might be given, and not only prevent their being moved, but show unmistakeably to the signalman that they are locked, so that the straining of the working parts by futile attempts to work them is avoided.

Mr. Dering exhibits some spring clips for the joints of rails and spring keys, and trenails for railway chairs. They are made of tempered steel, and are hollow, having a slit down their entire length, which admits of compression in driving them, while their tendency to expand again keeps them in their places.

The Post Office authorities exhibit an excellent working model showing the system adopted in England for depositing and taking up the mail-bags at stations where the mail-trains do not stop. The apparatus at the stations consists of one or more delivering-cranes and receiving-nets. The former are upright posts with a projecting arm, at the end of which is a catch for holding the mail-bags, which are retained in position by springs, adjusted so as to open at a pressure of 20lb. The latter are strong nets with an elastic rope apparatus across the mouth of them, for detaching the bags from the train, and are placed at a short distance from the stations, to prevent the risk of accident to persons on the platforms.

The travelling post-office train consists of three carriages, with a continuous communication throughout. Two of them are used for sorting the London and the country correspondence respectively, the third being devoted to the delivery and reception of the mail-bags. All projections in the interior, which are as few as possible, are covered with stuffed cushions, in order to lessen the effect of a collision on the officials. The receiving apparatus consists of a strong net placed in front of a window at the side of the carriage, and when not in use it is folded up flat against the side, where it is secured by a self-acting catch. The mail-bags, after being caught up by the nets from the station cranes, are taken into the carriage through the window. The delivering apparatus consists of two projecting arms at the sides of the carriage door, with spring attachments at the outer extremities for holding the mail-bags. These arms are hinged at the base, and have a counterpoise attached, which works in a covered sheath, and by which they are drawn up against the side of the carriage on being relieved of the weight of the mail-bags. Should it be necessary to deliver more than one bag, the second arm is used. This is secured out of the way at other times by a catch, which is not released until the first bag has been delivered. The French postal authorities attempted some time since to carry out part of this plan, but from imperfection in their machinery, accidents arose, which induced them to abandon it. They have now, however, taken the subject into consideration again, from observing the success of the system in England.

From Canada the principal object exhibited is the model of a carriage, showing the mode of arranging the berths.

MACHINE TOOLS, CLASS 54, IN THE PARIS EXHIBITION.

By J. ANDERSON, Esq., C.E.

Class 54 contains the various descriptions of machine tools that are employed in the working of wood and the metals generally, more especially the working plant of the mechanical engineer, such as lathes, planing machines, and other instruments by which form and precision are given to works of construction.

In this department of practical science Britain has hitherto been pre-eminently the leading country. At the Great Exhibition of 1851 it may be said to have been without a rival; the display of machine tools then made by some English houses took the world by surprise; the French and German, and even the American, engineers were not prepared for such refinement of form combined with solidity of construction, the several

fittings having a degree of precision never seen before, and yet constructed with such severe simplicity of arrangement in every detail, which by general consent placed England above comparison with the rest of the world.

The effect of that display immediately told, not only upon the machinists of other countries, but likewise on our own of second and third degree; and by the arrival of the Paris Exhibition of 1855, it was at once perceptible that a great change had taken place. Then, for the first time, a symptom of rivalry on the part of both France and Germany was visible, but still more remarkable was the general improvement in the productions of some of the English houses, resulting from the high standard of toolmaking set up by Whitworth and others in 1851. The slender forms of construction of former times began to disappear and to be replaced with the sounder and more grateful outlines of hollow framing which are now so general.

There was a great movement between 1855 and 1862 in regard to this class of machinery, not only in Britain but all the world over. In Britain an immense effort was made by many of the leading firms, and when the Exhibition opened, the great advance made was apparent. This advance did not consist so much in new invention as in the progress of the second class towards the point reached at previous exhibitions by those of the first class; nevertheless, there were still, to the close observer, a great difference in the style, fitting, and general finish of the various houses, and, as a rule, the highest of 1851 carried off the palm in 1862. But the notable feature of 1862 was the marked progress of other countries, especially in France, Prussia, and America.

When the Exhibition for 1867 was contemplated, the several countries looked at the competition from different points of view. Britain, conscious of former victory, was lethargic; the majority of houses were tired of the unremunerative expense of former exhibitions, and hence it is that this country has not come out in proportion to the extent of her industry, and but for the circumstance that a few of the best makers have come forward, Great Britain would have been unrepresented. On the other hand, the variety and number of tools exposed by France and Germany is enormous, and out of proportion to the extent of their manufacture of these articles. At the same time, the strong family likeness which the greater number present to the best English tools is a most striking feature; the same remark also applies to ourselves, for it must be confessed that real excellence, the power of real advancement, does not belong to nations but to individuals. During the last thirty years great strides have been made by a few men; their arrangements and forms have been repeatedly copied and put under so many transformations that the world really forgets the origin, and comes to give any maker who may have about him sufficiently skilled draughtsmen or workmen the credit which belongs only to the original; but a more healthy tone is spreading, and the time is fast approaching when to use other men's forms or mechanical arrangements will be looked upon as we now do on plagiarism.

Even the French, who are usually so prolific in invention, have mistrusted themselves in this department. In regard to steam engines, their ingenuity has run wild in the variety of their designs, arrangements, and combinations; but in the matter of machine tools it is otherwise. In 1862 they were impressed with the grand simplicity and solidity of the English tools as compared with their own, and in their laudable desire to excel on this occasion, they have rather overdone many of their machines in these particulars; yet it must be confessed that, notwithstanding many glaring defects, their display upon the whole is magnificent, whether prompted by individual or from patriotic motives, and, judging by their efforts in the matter of steam engines, we have every reason to expect that when the toolmakers of this nation feel themselves on an equal with England they will give over imitation, and strike out into the boundless region of mechanical combination which lies open to us all.

The display of tools from Germany is also grand; upon the whole they are fully equal to the French, and almost equal to best English. So far as design is concerned, they are as a rule strictly English, although there are many exceptions.

It is not, however, in the departments of France or Germany that the English tool student will find the greatest treat; in the machines from those countries there are many familiar forms and arrangements, beside much that will disappoint him, such as scraping for mere ornament instead of for surface, the marks being arranged in squares or diamonds by way of a pattern as in calico printing; he will find additions to machines put on in another character from the order or style of the original machine, and with the fitting barely up to the Whitworth standard; hence the lesson which is taught is more of a commercial than a scientific character. In America, on the other hand, he will find something new, not only exquisite workmanship of the highest class, but new combinations even in connection with such a stereotyped article as a turning lathe or a planing machine, and without the loss of any of the essential points secured by English models.

Such a visit it the proper spirit will serve to show the necessity of fresh thinking on the part of our young toolmakers; it will stimulate to a closer search for better combinations, and thus may they expect to hold the place achieved by their fathers.

FRANCE.

France having the most extensive display of tools in this Exhibition, and being first in the general catalogue, it will be convenient to commence with that department, and in the order which they occupy in the building.

Deny, of Paris (36), has made a moderately good show of small tools, especially for cutting plate-iron by means of circular shears; likewise a convenient mode of working the ordinary screw fly-press by steam-power instead of by hand. Although neither of these appliances is new, still they are not so much appreciated in England as they ought to be. In working the fly-press, a band of leather is attached to the outer edge of the fly-wheel on top of the screw; immediately over is placed a shaft with two discs almost touching the outer and opposite edges of the leather; by means of a handle with a lever the disc shaft is pushed on one side or the other, and so imparting motion to the fly-wheel accordingly in the required direction.

Ducommun, of Mulhouse (29), has a fine show of machine tools, mostly in the English style; lathes, large and small; planing, slotting, and drilling machines; and, upon the whole, the workmanship is very good, although not uniformly so. Their large lathe, if not the best in the Exhibition, is a grand tool, which has been carefully worked out in most of its arrangements, and the workmanship in some of its details is exquisite. The arrangement for disengaging the back gear is very perfect, the teeth of the worm-wheels being cut out of the solid metal in a very superior style, and with the worm fitting into the teeth in a manner which we seldom see; on the other hand, the details of the V frame in the middle of the bed of this large lathe, although convenient, are not in keeping with the general design, and the position of the gap in the break lathe is evidently in the wrong place. The large drilling-machine is of doubtful proportion; but, notwithstanding all this, the several tools are of a high order,—good, sound, honest articles, and superior to any French tools of a few years ago.

Périn (1), of Paris, makes a good show of machines, chiefly in connection with the treatment of wood. It was Périn who brought out the endless band saw in 1855; he is still the largest exhibitor of such articles. Some of his machines are of large dimensions, with a saw nearly 3in. broad; but the greatest triumph of the band saw is from England, by the Secretary of State for War, from the royal carriage department at Woolwich, by showing that Périn's saw is equally applicable to metal. The most of Périn's boring tools and sawing machines are worth careful examinations; but the latter have been developed in so many different ways by other makers that it becomes difficult for the inventor to keep pace with the world.

Santreuil (30) has some good machines for working in wood, especially one for mouldings, in which the undercutting is very fine. Some of the products of these machines are so perfect as to fully warrant the most conservative builder in discarding the old tools.

Normand, of Havre (34), shows a simple arrangement of vertical saw-frame, intended to cut the ribs of wooden ships; it is capable of cutting on the skew or curve as easily as in straight lines. This machine, although rudely made, is thoroughly practical and well thought out in its details, and uncommonly convenient for the purpose intended, as performed by men who may not be expected to have much skill for more refined arrangements. This tool is worth the attention of shipwrights who still employ hand tools; but, as a whole, it is inferior to the band saw.

Soulfort, Malliar, and Meurice (43), exhibit a collection of machines intended apparently for engineers in a small way of business. The most of them are contrived for working by hand, and more in the old French style than in accordance with modern notions. An examination will show the change which is taking place.

Duval, of Paris (53), have a few engineers' tools with some good points; yet without any special advantages; their drilling-machines are placed upon the top of a column, which certainly does not improve their appearance or add to their stability.

Lecacheux, of Paris (40), displays a few simple hand machines, chiefly for clipping and punching iron; they have the lever combination so well arranged as to surprise some at the shearing result which can be accomplished by exerting a small pressure upon a lever over a long distance.

Enodeau, of Paris (41), has two very simple machines of the lathe class, for producing the very peculiarly-shaped heel of the modern Parisian ladies' boot. They are a good deal after the Blanchard arrangement of lathe, and produce the required article cheaply and quickly.

Messmer, of Graffenstaden Works (60), has a grand display of engineers' machine tools, some of them magnificent in design and proportions. Their chief machine, and one of the most remarkable tools in the Exhibition, is that for drilling and slotting the wrought-iron framing for locomotive engines; it is deserving of careful study, and will be found to contain many good points, as well as some defects; but no one can fail to be pleased with it as a whole, and to feel that the time has arrived when we shall have formidable rivals to compete with. Machines of the same character have been made in England by Smith, Beacock, and Tannett, of Leeds, and by others, which in some of the arrangements of gearing were even superior; for when the saddles of this machine are brought to the driving side, the overhanging portion of the shafts must be objectionable, besides the room which is wasted. A machine of this high character may well bear criticism, for, as a whole, it is probably not to be matched by any machine of the kind

in the world. A slotting-machine, arranged for cutting the teeth of wheels by the slotting-tool, is rather doubtful, when considered from an economical point of view. This machine does not come up to the high standard of the grand tool, either in its proportions or disposition of the metal, especially in the back parts of the framing, where it is clumsy, which is the more surprising, as they have alongside a smaller machine of the same nature, which is almost faultless in its harmony of form and proportion.

Bonhey, of Paris (62), makes a great display of large, massive, heavy tools. They are not so finely constructed, nor are they beautiful in outline; but they are strong and serviceable, and may suit many branches of trade in France, as we see the same class of tools extensively made on the other side of the Channel and find a large market. One remarkable machine for shearing and punching is provided with four instruments—one at each end, as usual, with two additional tools introduced in the middle. The merits of the arrangement have been freely discussed in regard to the economical advantage as compared with two distinct machines; still, it is well deserving of close scrutiny, for future guidance.

The Ocean Company (No. 7) make a most imposing show, and the greater number are first-class tools, difficult to surpass; others, again, such as lathes, are inferior to those from the best English houses. Two machines for vertical planing are especially deserving attention. One of them has a vertical stroke of 14ft., and is provided with a small steam-engine, placed on the rear of the framing; the whole combination being well arranged, and the workmanship quite up to the present times. They also exhibit a boring machine, which, like the vertical planers, has quite a character of its own; it is driven by a worm gear, and is sound and good in all respects. Their radial drilling-machine is not so remarkable; indeed, there are trifling points which might be modified with advantage to the future proprietor. It is surprising how many of the radial drills in the Exhibition have not been sufficiently thought out in their details to enable the drill to be brought to the centre point without the operator having to remove his eyes or change his position to make the adjustment.

The Imperial Manufacture of Arms (64) exhibits an assortment of machines for drilling and rifling steel gun-barrels, and for other purposes connected with the manufacture of small arms. The whole plant is simple and well designed for the work intended, and will prove good, serviceable machines; but they contain no points of improvements in advance of similar machines used in England.

Cail and Co. (32) show a lathe and drilling-machine, both passable tools, but without remarkable points requiring special notice.

Varrall, Elwell, and Poulot (59) exhibit an extensive collection of engineers' tools, mostly after the English style. This firm is celebrated in France for the best materials and workmanship. After hearing so much, the first impression on seeing their larger tools is slightly disappointing, not so much in regard to their soundness or efficiency as working tools, but rather in the appearance of the heavier parts. Considered merely as castings, many of them appear to have been moulded in loam, and that the mould had been fashioned a good deal by the hand of the moulder. The surfaces are slovenly in appearance, which detracts greatly from the beauty of the machine, and does not afford that pleasure which is derived when beholding the more graceful outlines of many other machines in this Exhibition. One of the machines exhibited is a large and massive punching and shearing machine, much in the style of De Bergue. It contains four instruments—two horizontal punches and two angle-iron shears. Altogether, it is a good specimen; and the more important parts are executed with unexceptionable workmanship. They also show a well-constructed steam-hammer, on the Naylor plan; but with all the good and bad points of that system. Their slotting-machine is well constructed, the breadth of the tool holding part of the slotting-bar is perhaps an exception. This peculiarity distinguishes a considerable number of the Continental slotting-machines. It has one advantage; for, admitting that it gives a defective twist when a single tool is used upon one of the edges, yet the great length of the slotting-bar more than compensates, while the breadth affords greater facility for the simultaneous operation of two or more cutting-tools. The lathes shown by this firm are about the best in the French department. Upon one of their lathe-beds is placed transversely a pair of headstocks for operation with milling or other tools at right angles, no doubt intended for some special purpose; indeed, the introduction of special tools is a remarkable feature all through the foreign department of the Exhibition, more especially chucks, angle-plates for every conceivable kind of fastening, and many other similar conveniences. They exhibit a remarkably good drilling-machine for the boring of shell; this tool has been well considered throughout, and will bear any amount of scrutiny. They also show a shaping-machine, which is uncommonly well made; it contains the best points of the best machine as made by English houses. The power is applied direct to the shaping-bar, a point frequently neglected, to the manifest disadvantage of many machines of this class. The form of the teeth of wheels, as made by this and other French firms, is worth special notice. This is partly due, no doubt, to the great diffusion of mathematical and scientific education in that country. Such knowledge fosters a love of these refinements, and at the same time gives the power to develop them, and secures for any nation possessing it a higher vantage-ground for the battle of industrial life.

Taken altogether, the French display is remarkable; and, remembering their position in 1851, and even in 1862, and now beholding the wonderful progress which has since been made, we may rest assured that, beside school learning, the people have great aptitude for mechanical pursuits, and are most skilful as handicraftsmen in every description of smithing and the working of metals.

Should any doubt exist in regard to the position attained by France, a visit to the collection of Schneider, of Creusot (113), is recommended. It is contained in a building in front of the French machinery annexe; there will be seen the largest display of machinery ever made by a single firm—steam-engines of all descriptions, an engineering tool of the highest class, smithwork of which any nation may be proud, and samples of iron which, for malleability, is so far superior to anything which we are accustomed to handle as must suggest painful misgivings in every patriotic mind.

Belgium.

Although Belgium comes out in great force with regard to steam-engines and other machinery, yet the display made in machine tools is limited in number, and those exhibited are certainly not of the highest quality. As a rule, they are inferior to the productions both of France and Germany. The chief exhibitor is the firm of Cail, Halot, and Co. (1); but even their productions are not of a high type. Comparatively little originality is displayed in their construction, and the workmanship is scarcely beyond the range where surface scraping is resorted to for ornament. There is a large market for tools of this nature, and possibly they may meet the present requirements of their customers. One of their machines for planing the edges of boiler or other plates is well designed, and all their other tools are good, serviceable articles, well adapted for the ordinary work of an engineer.

Fétu and Deliége, of Liege (4), exhibit a few tools, mostly of the common type; it will be observed that the toothed gear has been cut out of the solid, and the workmanship altogether is of fair quality.

The firm of Detombay show two good steam-hammers. The framing of the larger one is a grand specimen of design and casting, and is similar in arrangement to that of a 12-ton hammer made by Mr. Wilson, of Patricroft, for the Royal Arsenal a few years ago.

By a visit to the Belgium annexe another opportunity will be afforded of examining the progress of toolmaking in this country. Those exhibited in the annexe are moderately good, rather too light in structure, and the spindle of the large lathe rather too small in diameter; still, they are good, honest tools; and, taking them altogether, they belong to the average of 1855, and inferior to the best tools of the present year, though superior to the majority of the Belgian tools.

A visit to this annexe will be well repaid by seeing a marvellous specimen of casting, the sight of which ought to make our founders reflect. The article in question is simply a cast-iron pipe lying in the corner beside the lathes above referred to; but this pipe is 20ft. long, 28in. in diameter, and varies from $\frac{1}{4}$in. to $\frac{3}{8}$in. thick throughout; it is said to have been proved to five atmospheres, and can be sold at the same price per cwt. as pipes of smaller sizes and of the ordinary character.

Prussia and the Northern States of Germany.

From the display of machine tools made by some of the German houses in the Exhibition of 1862, it was anticipated that a great effort would be made for the present Exhibition; but the display which is made, both in regard to quality and quantity, is far beyond the most sanguine expectations; and, whatever may be the explanation of the rapid progress made in this kind of machinery, both in France and Germany, the fact remains for our information.

Zimmermann, of Chemnitz (11), exhibits a grand collection of machine tools, both for the working of wood and metal; one in particular, for shaping the teeth of large wheels, both spur and bevil, has deservedly attracted great attention for its perfect adaptation to the precise fulfilment of the object intended, and is quite a study in itself; although not an original design (a similar machine having been made by Shepherd, Hill, and Co., a few years ago), still it is a good specimen of toolmaking. In the formation of the various curves of the teeth the form is produced from a perfect copy, which, by the mechanism, is correctly transferred to every tooth in the wheel to be operated upon in succession; the surface of the bevilled tooth being made up of various curves finely shading into each other, the mode of transferring such a recondite figure is admirably carried out—all the motions are concentrated for transfer upon the end of a hemispherical fixture. This machine is self-acting in most respects, even to the depth of the tooth; but it is not perfectly automatous, and so requires attendance. It is, however, well deserving of, and will repay the attention of, the millwright and toolmaking student. Many object to its want of compactness and for not serving as a lathe to turn the wheels; still it is an admirable tool, which any maker may be proud of.

The means employed for giving a quick return motion to the planing-tool of a shaping machine, by means of a double set of eccentric wheels working in unison, is well carried out; they seem to act very satisfactorily, and without a catch, as might be expected.

The nut-shaping machine is also very simple and neat, and will be difficult to improve upon. Likewise a machine for planing wood mouldings, another machine for curved mouldings, and a wood-planing machine, are all very superior, and leave little to be desired by the builder or carpenter. They also show a small jigger saw, in which the saw is turned about by the feet of the attendant in a simple manner. This tool is likely to be extensively adopted by builders of railway stations, or others who have much to do in ornamental fringe sawing. M. Zimmermann also shows the mode of grinding cutting-instruments which he has adopted. The tool, instead of being held by the workman, is held to the grindstone by an iron hand at the proper angle.

Altogether this display is of a very high class, and accompanied with great refinement, while the defects are not nearly so conspicuous as in many of the Continental houses; although in some instances scraping has been performed for ornament, which would detract greatly from their value in the English market.

Hartmann, of Chemnitz (10), shows some fine tools of the largest class—a lathe for turning railway wheels, a beautiful slotting-machine, and a shaping-machine, probably the largest in the whole Exhibition. This display cannot fail to teach us, as a nation, that from henceforth we can no longer reckon on the trade in tools as our own inheritance; indifference on the part of masters, or a few more strikes on the part of workmen, may easily divert the current from the old channel.

Sigl, of Berlin (1), exhibits a fine collection of machine tools and other machinery, all of very superior design and construction. One from Britain acquainted with English tools, while seeing a great deal to remind him of old friends at home, must also allow that much originality of form, and even of arrangement, has been displayed in many of the machines exhibited by this house. At the same time, there are but few remarkable points of distinction that require special mention.

Wagner and Co. (2) show some tools of inferior quality, more especially in regard to workmanship; for example, observe the scraping in the cross slide of the planing-machine; it is throughout damaged so deeply as to require being re-planed, yet, no doubt, it has been done by way of ornament.

Collet and Englehardt, of Hesse (1), make a large display of machine tools, mostly very good, and some of superior quality; in some, however, such as the slotting-machine, the partiality for Manchester is too conspicuous; a firm with the capabilities they posses might safely rely upon their own resources. The self-acting lathe is not much admired, being too complicated and inferior in arrangement to many other lathes in this Exhibition; the workmanship, however, is very fair throughout, although not equal to the best of either France or Germany.

Schmaltz, of Offenbach, have some good machines for working in wood, especially one for cutting mouldings; but none contain any remarkable points for the student, with the exception of a simple machine for rebating and joining pieces of wood of any figure—hexagonal, rectangular, or, indeed, of any geometrical form. The dividing arrangement is similar to that of a nut-shaping machine, and for this purpose is all that can be desired.

In the department of the grand duchy of Hesse there is a most interesting and instructive collection of models of mechanical motions and movements, and also the necessary apparatus to explain every detail of machinery and engineering, besides models to illustrate the mode of constructing patterns for the foundry. The above is, probably, the most perfect collection ever shown; the prices quoted are fair and reasonable, and the whole display is worth the attention of all who are connected with the instruction of young engineers.

Professor Boylich, of Bavaria, in class 53, exhibits two very ingenious and original combinations of cog-wheel gearing for the transmission of motion, which afford great facilities for the changing of direction without any disturbance of the mechanism beyond the actual performance. The tool-student should carefully examine these wheels with the view of turning them to account at some future day, for as yet they have had no practical application; a probable outlet for them will be in connection with tools requiring continuous motion under varying conditions and circumstances.

Baden.

Geschwind and Zimmermann, of Carlsruhe (1), make an admirable show of engineers' tools, good forms prevailing in almost all. The workmanship is about the average quality, but there are few, if any, original points; notwithstanding, they are beautiful specimens, and, as a whole, are good, sound, honest tools.

Austria.

Although Austria does not make any great pretension at this Exhibition as a machine-producing country, still, there are some very fair specimens of tools exhibited, which, as in other countries, may yet develop to greater proportions.

Ganz, of Hungary, exhibits a dovetailing-machine, for cabinet or other work, which performs its duty very satisfactorily. With a little more thought spent over its details, this tool could be simplified and improved into an efficient practical machine. They also show a very good machine, on the American type, for boring railway wheels. A true surface, the shape of the rim of the wheel, is placed under a vertical boring apparatus; the wheel is simply laid in and fixed; it takes its place truly by the outside surface, and is bored in accordance. This, of necessity, implies absolute truth in the relation of the bed to the cutting instrument.

(To be continued.)

ROYAL AGRICULTURAL SOCIETY'S SHOW AT BURY ST. EDMUNDS.

In our last issue we gave the result of the trials of the engines entered by the various makers; the increased entry for, and the competition amongst them, and also the manufacturers of thrashing machines, and other food-preparing implements, was very severe, so much so that the labours of the judges extended considerably into the second week.

One of the most useful features of the Exhibition, and which is likely to lead to good practical results, were the designs for pairs of labourers' cottages. No fewer than sixty-three competitors sent in plans which were accompanied by elevations, sections, detailed specifications, and estimates of the cost of each item. The cost varied from £106 to £338 the pair; the winning designs costing from £170 to £190. It is to be hoped that a selection, if not the whole, of these designs may be published. The winners were:—1st. Messrs. Conder and Laslett, architects, 1, Park-lane West, London; 2nd. Mr. Thomas Shaw, 29, Bridge-street, Birkenhead.

The following were the awards of the implement judges:—

Fixed Steam Engines.—First prize, £20, Clayton, Shuttleworth, and Co., Lincoln; second, £10, Tuxford and Sons, Boston; highly commended, Reading Iron Company; commended, Rawlings, Melbourn, Royston; S. Kinsey, Nottingham; Deacon and Wood, Reading.

Portable Steam Engines (with two cylinders, above ten horse-power).—First prize, £25, Clayton, Shuttleworth, and Co.; second, £15, Ransomes and Sims, Ipswich; highly commended, Tuxford and Sons; Brown and May, Devizes.

Portable Steam Engines (with one cylinder, not exceeding ten horse-power).—First prize, £25, Clayton, Shuttleworth, and Co.; second, £15, Tuxford and Sons; highly commended, Reading Iron Company; Brown and May; commended, Rushton, Proctor and Co., Lincoln.

Thrashing Machines.—Portable thrashing machines, not exceeding eight horse-power, which prepare for the Finishing Dressing Machine—First prize, £20, Ransomes and Sims; second, £12, E. Humphries, Pershore; third, £8, Nalder and Nalder, Wantage.—Portable Thrashing Machines to be worked by horse-power not exceeding that of four horses—First prize, £12, Wallis, Haslam, and Stevens, Basingstoke, second, £8, Tasker and Sons, Andover.—Thrashing and Finishing Machines—First prize, £20, Holmes and Sons, Norwich; second, £15, Clayton and Shuttleworth; third, £5, Marshall and Sons, Gainsborough.

Chaff Cutters.—Chaff cutters by steam or horse power: First prize, £10, Richmond and Chandler, Salford; second, £6, E. H. Bentall, Heybridge, Maldon; third, £4, Picksley, Sims and Co., Leigh; highly commended, Carson and Thome, Warminster.—Chaff cutters by hand power: First prize, £6, Richmond and Chandler; second, £4, E. H. Bentall; highly commended, Smith and Grace, Thrapston; commended, J. Cornes, Barbage, Nantwich; E. Pape and Co., Bedford; and J. Cornes, for another machine.

Crushing Mills.—First prize, £8, Woods and Cocksedge, Stowmarket; second, £7, E. R. and F. Turner, Ipswich; third £6, E. H. Bentall; fourth, £4, E. R. and F. Turner; commended, Woods and Cocksedge.

Hand Dressing Machines.—Corn Dressing Machines: First prize, £12, Tasker and Sons; second, £8, Corbett and Son, Wellington, Salop; commended, R. and J. Reeves, Westbury; and Ransomes and Sims.

Turnip Cutters.—First prize, £10, Hornsby and Son, Grantham; second, £5, Ransomes and Sims.—Turnip Pulper: Prize, £5, Hornsby and Son.—Root Pulper by steam power: First prize, £6, Hornsby and Son; second, £4, E. H. Bentall; commended, E. H. Bentall, for Turnip Cutter and Turnip Pulper; and Picksley and Sims, for Turnip Pulper.

Oilcake Breakers.—By Steam Power: First prize, £10, Amies and Barford, Peterborough; second, £5, E. H. Bentall.—By Hand Power: Prize £5, R. and R. Hunt, Earl's Colne; and prize, £5, E. H. Bentall; commended, E. R. and F. Turner.

Corn Screens.—Prize, £10, Hornsby and Son; commended, R. Boby, Bury St. Edmunds; Penny and Co., Lincoln; and Ransomes and Sims.

Barley Hummellers.—Prize, £5, Holmes and Son.

Mills.—Grinding Mills with Metal Grinders by Steam.—Prize, £20, Amies and Barford.—Grinding Mills; First Prize, £6, Smith and Grace; second, £4, S. Corbett and Son.—Bone Mills: First prize, £10; Beverly

Iron and Waggon Company; second, £6, Beverley Iron Company; third, £4, Beverley Iron Company.—Stone Mills: First prize, £9, E. R. and F. Turner; second, £6, I. Tye and Co., Lincoln; commended, Ruston, Proctor, and Co., for Stone Grinding Mill.

FIELD GATES.—Prize, £10, J. Braggins, Banbury.

MISCELLANEOUS.—Silver Medals to Woods and Cocksedge, for horse gear; Burney and Co., Poplar, for strong wrought-iron cattle troughs and cisterns; Webb and Son, Stowmarket, for assortment of leather machine bands: Warner and Son, Jewin-street, London, for chain pump for liquid manure; Boby, Clarke, and Co., Bury St. Edmund's, for draining tools and forks: A. B. Child, Oxford-street, London, for patent aspirator; Tangye Brothers and Holman, Laurence Pountney-lane, London, for 4in. double-suction pump; A. Wrinch, Ipswich, for assortment of garden spring chairs, and collection; Musgrave Brothers, Belfast, for stable fittings, cow-house fittings, and piggeries; and Clayton, Shuttleworth, and Co., for adjusting blocks for fixing engines and thrashing machines. Commended: J. Baker, Wisbeach, for elastic rake; Hawkes and Spencer, Tiverton, for chain drill; J. and F. Howard, Bedford, for haymaker; Hornsby and Son, for improvement in mower; Burgess and Key, Newgate-street, London, for improvements in mower; Wilkinson and Son, Ely, for improved horseshoe; Ransomes and Sims, for turn-wrest plough; J. Grant, Bankside, London, for portable railway and turntable; Ransomes and Sims, for guard for preventing accidents by drum or thrashing machine; Ransomes and Sims, for lawn mowers; J. D. Young, Clapham-road, for iron gate; F. Morton and Co., Liverpool, for iron gate; Bayliss and Jones, Wolverhampton, for iron gate; St. Pancras Iron Works Company, for iron gate.

BRIDGE OVER THE MISSISSIPPI.

The following particulars respecting a bridge designed for the purpose of connecting the city of St. Louis with the entire railway system of the northern states of America, will perhaps be interesting to our readers.

The design has been prepared by Mr. Eads, the chief engineer to the company, and it is so arranged as to avoid any interruption or embarassment to the large traffic on the river. The bridge will cross the river on three magnificent arches of cast steel, surpassing in extent of span anything of the kind yet constructed. The two side spans will be 497ft. each, and the central 515ft. in the clear between the abutments. In ordinary stages of water there will be from 60ft. to 75ft. in the clear below the bridge at the central arch, and but a few feet less under the side ones. At high water mark there will be about 50ft. These great spans will give sufficient room for steamers, and, when the wharf is completed, the judicious division of it, effected by the site of the bridge, between steamers trading above and in the lower rivers, but little necessity will exist for their passage under the bridge in arriving or departing. The roadway for railway trains, through which a double track will be laid, and which of course forms a permanent object of interest in the construction of the bridge, will be suspended from the iron beams supporting the carriage way, and will rest on the lower chords of trusses, extending from Water-street to the middle of the block between Second and Third-streets. The *tracks* will be carried *over* Main-street at a sufficient height above the street to obviate any inconvenience. It is intended that these tracks shall be arranged to accommodate trains going in any direction, whether of 6ft. or 4ft. 8½in. guage, each track having an extra or third rail. By this means the closest possible connection can be made by all railroads centring at St. Louis, from whatever direction, through the very heart of the city, and without danger or annoyance.

The appearance of the bridge when completed, judging by an inspection of the plans, will be striking and beautiful. In general style and character it will resemble the celebrated bridge over the Rhine at Coblentz.

The most difficult portion of the work is the building of the main piers. Owing to the shifting nature of the bottom of the river, which, opposite the city, is composed of sand, varying from fifty to eighty feet in thickness, under which is a hard stratum of rock, it becomes absolutely necessary that the piers should be built upon the rock, as in high water the sand "scours" out to a great depth. To accomplish this, one of the two central piers must be constructed through water and sand over seventy feet in depth, and the other nearly one hundred feet. The great cost of putting these piers down to the rock renders it a desideratum to have spans of unusual length, thus by diminishing the costly work of the substructure a more moderate expense is incurred by framing the superstructure accordingly. The great length of the span, however, increases the weight to be borne by each pier and necessitates the construction of piers of great massiveness and strength. We have also here another important difficulty. These piers must be finished to a point above water between the periods of ice and floods, so as to prevent injury when in an unfinished state, and hence to complete the work in the short time that intervenes between the seasons, becomes a most complex and difficult problem. These piers will be about 100ft. by 50ft. at the bottom and tapering to the top, where they will be about 70ft. by 30ft. at the level of the carriage way. One will be about 165ft. high and the other 195ft. from the rock. In the latter there will be about 13,000 cubic yards of masonry below the surface of the water at ordinary stages. We now catch a glance of the engineering problem presented in the construction of these piers. Here we have 13,000 cubic yards of masonry, which must be of the most compact and solid nature, weighing in the aggregate between 27,000 and 30,000 tons, all of which must be placed in position 80ft. deep in sand under water, within three consecutive months, in a river with a current running four to five miles an hour.

We will now endeavour to give some idea of the means by which the substructure of these giant piers will be erected. Around the site of the pier, a number of screw piles, 16in. in diameter, will be sunk. These can be rapidly screwed into the sand and forced down to the rock. On these piles a strong framework of timber will be erected, within, and supported by which, a huge boiler-iron caisson, well strengthened by angle iron bars placed horizontally around it about three feet apart on its inner surface, will then be put together with screw bolts. This caisson is simply intended to be used as an iron curtain of an elliptical shape, open at the bottom, and being considerably larger than the intended pier, will completely surround it. It is not the design to pump the water out of it, and hence it is not braced across from side to side, but is simply designed to exclude the sand. It will be suspended from the wooden framework by a number of rods which will be worked by screws above, and by which it will be lowered into the sand. It will be held against the current by chains until it sinks by its own weight into the sand. When it has sunk to a sufficient depth, the work of pumping out the sand is commenced, which will be done with powerful sand pumps, and as the caisson will be slightly larger at the bottom than at the top, its inclined sides will facilitate its sinking as the sand within is removed. In this way it will finally be sunk to the rock, and reaching above the surface will completely enclose the water within it. The sand being removed from the rock, a bed of concrete mortar will be spread over the rock and carefully levelled off. This mortar bed will be one or two feet in thickness above the highest parts of the rock. Things being thus arranged to receive the pier, a portion of the down stream end of the caisson will be temporarily removed to admit within it a huge flat-bottomed boat. This boat will have its bottom constructed of squared timbers, placed solid, and of about eighteen inches in thickness and thoroughly caulked. It will form the basis of the pier—wood, as our readers are doubtless aware, being practically indestructible under water. The sides of the boat will be nearly vertical, and made of strong timbers and plank, and caulked tight. In this vast vessel, the interior of which will be of the size and shape of the intended pier, the masonry work of the pier will be laid as fast as ten or twelve steam hoisting machines on the frameworks above can supply stone and other materials to the masons working within it. As the masonry progresses the boat slowly settles down with its gigantic load, and as it sinks the sides are built up to exclude the water, and will ultimately reach a height of 100ft. It is estimated, when about 40ft. of the pier has been constructed, the boat will have reached the bed prepared for it within the caisson, and will then rest upon the rock. The masonry will be built up rapidly, the massive stones being thoroughly grouted, course after conrse with hydraulic cement, until the structure gradually emerges above the surface of the water. The sides of the boat will be secured by screws, which can be loosened when the stonework has reached the surface; the boat will be permitted to fill with water, when the screws will be disengaged and the side will be taken out. The next step will be to remove the iron caisson. The screws supporting it will be put in motion, and it will be drawn up from the sand, unbolted, and removed to be used in the construction of the other pier. The upper framework will then be taken down, and the screw-piles withdrawn. The pier will be then completed a few feet above the surface of the water, and will be then left alone to withstand the rush of ice and flood, and will be completed in proper season. The construction of these piers is certainly the most hazardous and difficult part of the undertaking, but previous to the commencement of the work, every possible preparation which scientific foresight can suggest to insure against delay, will be taken.

Each of the great spans will be formed of four ribbed arches of cast steel, having a rise of about one-tenth of the span. Each one of these will be formed of two ribs placed 7ft. apart, one above the other, and strongly braced between, with diagonal steel braces. The carriage-way and railways of the bridge will be supported over the wharf on either side of the river by five stone arches of 30ft. span. These terminating arches will form an architectural feature of an important character, and will add much to the impressive appearance of the great structure.

The cost of the bridge and tunnel, exclusive of real estate, is estimated at 5,000,000 dollars. The real estate will cost probably cost 750,000 dollars additional. It is anticipated that three years will be required for its completion.

THE PALLISER CONVERTED GUNS.

Our arsenals and dockyards, our harbours and forts, can never be deemed approaching to security until something is done with their cast-iron smooth-bore guns, and the number considered, at this moment useless, can hardly be computed, our forts, everywhere being armed by these inefficient weapons. Major Palliser, beyond all doubt or question, has practically accomplished what should be done with them, if the most recent successes be admitted as a test. Taking the last example, we may refer to the trials at Shoeburyness on the 9th inst. of a 32-pounder, converted by the Elswick Company by boring up and lining in the same calibre as before, namely, 6·3 inches, with a coiled wrought iron tube. The original service charge of this piece as a cast iron smooth-bore gun was 8lb. of powder projecting a 32lb. shot. On the day referred to above seventy rounds were fired from the converted arm. Fifty of these were with 8lb. charges, and 64lb. common shell, and twenty with 16lb. of powder and 80lb. chilled iron shell. The range, with 10 degrees elevation, was about 4,200 yds., and the working of the gun was admirable to the completion of the experiments, when the metal was so hot that the hand could not be borne upon it. The object of these experiments was to lay down the range tables for the gun which will form part of the armament of Her Majesty's frigate *Nelson*, transferred by our Government to the colony of Victoria. This vessel will carry twenty of these 64-pounder Pallisier guns on her broadsides, and two 7-inch Palliser guns on her main deck on pivots. She will also carry on her voyage out five Armstrong muzzle-loading 9-inch 12½-ton guns in her hold, which are to be mounted for the harbour defence of Melbourne. The inventions brought forward by Major Palliser having been so strikingly opposed to the accepted opinions of the iron-workers and mechanicians of the day, as well as to prevailing interests, the strongest opposition has been met with and unusal and lengthened delay has occurred. Such has been the case with his chilled shot and his screw bolts, no one believing that brittle cast-iron could be made a more efficient material for shot for penetrating armour-plates than tough steel.

The enormous strength of a coiled iron tube *per se* has been experimentally proved by Major Palliser on a small scale, and he has found that a tube equal in thickness to the radius of the bore withstood charges which burst cast-iron guns of the same calibre with the usual thickness of metal, *i.e.*, 1½ times the diameter of the bore. To refer, however, more directly to the main experiments upon which the reliability of the Palliser guns depend, we may take first the case of the 68-pounder converted by the Government in 1862 into a 9-inch smooth bore. This gun passed through, without bursting, the ordinary test to destruction of cast-iron strengthened gun, viz., 100 rounds, with the service charge of 16lb. of powder, increasing every ten rounds the weight of shot by an additional 68-pounder. Thus the first ten rounds would be with one shot; the second with two = 136lb.; the third with three = 204; and so on up to the last ten, which were with ten shots, or 680lb. weight of metal. The recoil of the Palliser gun under this frightful charge was so violent that several carriages were smashed, and, finally, when the piece was slung, it pitched out of the chains and buried its muzzle upwards of two feet in the ground, but suffered no injury whatever itself. It is always considered that the increased weight of shot is the greatest cause of the destruction of the arm, and no cast-iron gun has ever endured such a test. If an inordinately large charge of powder combined with heavy shot be considered a severer trial, the Palliser guns have come out of that ordeal, too, with flying colours. A 32-pounder converted into a rifled 64-pounder has been subjected to every conceivable hardship. Thus, after numerous and trying tests, such as firing with the shot half rammed home, with air spaces between the shot and the powder, or firing shells, with 16lb. charges, purposely burst in the gun—the charge was increased, by 5lb. at a time, from 10lb. up to 30lb. of powder, fifteen rounds of each series being fired with rifle projectiles increasing from 50lb. to 150lb. in weight. At last the cast-iron casing or original fabric of the gun *cracked* under a charge of 30lb. of powder and 150-pounder shot, but this without any explosive properties whatever. There was merely the appearance of a slight fissure on the outside of the metal. The common danger of cast-iron guns is thus obviously overcome by Major Palliser's system, and complete warning by fissuring will take place in this class of weapons at a stage in the life of the gun antecedent to a state of absolute peril to the detachment of serving gunners. The coiled wrought-iron barrel lining the piece was bulged in the instance referred to fully a quarter of an inch, but there was no sign of the least fracture in it. Had this been a steel or ordinary iron barrel, it would undoubtedly have cracked instead of stretching, in which case the gun would have given way instantaneously and explosively. Considering this was a private experiment of Major Palliser, it must be conceded to him that he has fairly demonstrated on a large scale the extraordinary endurance and reliability of what is technically termed a coiled wrought-iron tube. It is now just thirteen years since he commenced constructing his guns with coiled tubes which were then in their smaller conditions as adapted to fowling-pieces known in the sporting gun trade as "twist" barrels, the fundamental principle of construction being in both cases the same, namely, the obtaining of a grain in the iron running spirally round the bore. This is the common principle, the development of which, on the large scale of coiled tubes for heavy ordnance, was accomplished in the first instance by Sir William Armstrong.

The last experiment with the Palliser guns for endurance took place about a month ago, and this was also a private one. The arm was a 10-inch shell gun converted into an 8-inch rifled gun at the Elswick factory. It was fired at the Arsenal proof cells, being placed at the bottom of a platform, inclined at about 15 degrees. Two rounds were fired with 37½lb. of powder and 180-pounder shot, and fifty rounds with 30lb. charges and the like shot. At the conclusion of the experiments the gun was not strained or injured. It recoiled from 30 to 40ft. up the plane; and it is true to the letter to say that no gun, whether of cast or wrought iron, of the same weight has ever been tried with such enormous charges. The weight of this converted Palliser gun is 4½ tons, and the above firing charges of 30lb. are the same as those for the 8-inch wrought-iron Woolwich muzzle-loader, weighing 9 tons, and throwing the same weight of shot (180lb.)

This mode of conversion, which may now be said to be properly perfected, is a straightforward mechanical work. A cylindrical cut is taken down the bore of the cast-iron gun, and a cylindrical tube, slightly smaller, is passed down and retained in its place by a screw-collar at the muzzle. This tube is then brought to a mechanical fit by what is termed a "setting-out" proof. The gun is finally bored to remove the bulge, and then rifled. Major Palliser also takes advantage of the principle which he introduced in his screw bolts to further secure the full longitudinal strength of the material of his gun. This mode of closing the breech of his tubes has been adopted by the government in all their wrought-iron artillery, and is quite as important in respect to the construction of cannon as it is in the bearing of strain in the screw bolts, tending in the highest degree to the safety and longevity of the gun; in fact, in itself, it would constitute all the difference between the blowing off the breech of a piece not so constructed and the perfect endurance of another so constructed, although both weapons were otherwise alike.

In respect to the experiments we have noticed, we ought to observe the great strength of our English powder, and in all comparisons of gunnery experiments with those of foreign countries this difference should not be lost sight of. About 1859-1861 numerous experiments were instituted in rifling our cast iron 32-pounders. Of these the greater proportion burst after a limited number of rounds with 5lb. or 6lb. charges projecting shot of from 50lb. to 60lb. On the other hand, we read of the French firing 16lb. of powder from a hooped cast iron gun of the same calibre, and projecting 84-pounder shot; and of the Italians firing 17lb. of powder and 110-pounder shot from 32-pounder cast iron rifled guns. Now, both the Italian and English guns have been made at the same works, those of the Lowmoor Company. In reality, the destructive effect of 16lb. of French powder is the equivalent of 6lb. of English powder with the same weight of projectile to move. Some French powder has lately been tried from our 9-inch Woolwich gun, and it has given a velocity to the projectile of 1,150ft. per second as compared with 1,300ft. by English powder. When it is remembered that the effects of shots vary as the squares of their velocities, it will be seen that the *vis viva* or working power accumulated in an English shot is as 169 to 133 for that of a French one.

Major Palliser's plan for converting the existing stock of cast iron guns being established, and entirely admitted by the Government, it is to be hoped that the necessary funds for putting it into practice may be at once voted. Until this conversion is carried out, our forts are practically defenceless against existing foreign fleets.

THE AMERICAN IRONCLAD RAM "DUNDERBERG."

The *Dunderberg*, which has lately been purchased by the French Government from its builder, Mr. W. H. Webb, has just made its first trip across the Atlantic, and the following are some particulars respecting the vessel and her voyage:—

The *Dunderberg* mounts 18 guns—four 15-inch and fourteen 11-inch. She was launched on the 22nd of July, 1865. Her dimensions are as follows:—Extreme length, 380·04ft.; extreme beam, 72·10ft.; depth of main hold, 21·07ft.; height of casemate, 7·09ft.; length of ram, 50; draught when ready for sea, 21; displacement, 7,000; tonnage, 5,090; weight of iron armour, 1,000lb.

She has six main and two donkey boilers. Her actual horse-power is 5,000; her nominal horse-power is 1,500. She is built of the best of choice timber. Her bottom is flat, her sides angular, and surmounted by the casemate for her battery. Her hull is built of square logs, securely bolted together, and the seams caulked inside and out. The entire structure is strongly trussed with diagonal braces of iron fastened outside the solid frame. The bulkheads are built longitudinally, as well as transversely, enclosing the engines and at the same time furnishing

ample space for the coal bunkers, which when filled with coal give additional security to the engines and boilers in action.

The ram is a portion of the ship, and is not bolted or secured as is generally done. It is the bow fashioned into a powerful battering-ram. To form it the vessel is filled in for 50ft. with a solid mass of timber, which is armoured with a wrought-iron jacket or front piece to protect it not only from a shot but any abrasion by contact.

The engine department proper is supplied with several powerful pumps, intended for clearing the ship of water in case of leak and protecting her in case of fire. There are also two sets of large hand-pumps and two eight-inch steam-pumps, which work independent of the engine and its numerous pumps. One of Normandy's condensers supplies, if necessary, 2,000 gallons of good drinking water per day.

The armour plates weigh 1,000 tons. They are manufactured in slabs of hammered iron, $3\frac{1}{2}$ inches in thickness, and 12 to 15 feet in length, and 3 feet in width. They are placed vertically, therein differing from other ironclads, on which the plates are placed horizontally.

The pilot-house is on the forward upper deck of the casemate. It is 8 feet in height and 11 feet in diameter.

The engines were built by John Roach and Son, of the Etna Ironworks, New York, under the superintendence of experienced engineers, acting on behalf of the Government and of Mr. Webb. They are the most powerful that have been built in the United States, and will make 60 revolutions per minute on 25lb. of steam, two small engines working the valve gear.

The pumping, condensing, and circulating engines will run at 45 revolutions per minute. The furnaces are arranged in two tiers, with two furnaces to each boiler. The donkey boilers have four furnaces each. The funnel is 13ft. in diameter, and at the point where it passes through the gun-room it is shot-proof. It contains a grating to prevent anything from coming down upon the engines.

The coal bunkers have a capacity of 1,000 tons, sufficient for twelve or fifteen days.

The *Dunderberg* first set out on the 4th of July, but had only advanced about sixty miles when the reversing gear of the engines broke down, and she had to return to New York. She finally started on the 19th of July, and arrived at Cherbourg on the 3rd of August, making the trip in 14 days, 17 hours, or an average of about $8\frac{1}{2}$ knots per hour.

THE "ALBERT GOLD MEDAL."

The Council of the Society of Arts, under the presidency of his Royal Highness the Prince of Wales, has recently announced the award of the annual grant of the "Albert Medal" to William Fothergill Cooke, Esq., and Charles Wheatstone, F.R.S., for their joint labours in the introduction of the electric telegraph in the year 1837. The medal itself is a work of high art by Wyon, and bears one of the best likenesses of the lamented Prince that has been attained. In its execution and unusual dimensions it is in every respect worthy of the object to which it has been dedicated, and of the great and good Prince, whose memory, as the friend and patron of the society over which he presided for eighteen years, it is intended to preserve. The origin of the "Albert Medal" is but little known, and we extract from the "Society of Arts" journal for the 13th Feb., 1863, the following condensed account:—"At a general meeting of the society, specially convened, Sir Thomas Phillips in the chair, held on the 21st of March, 1862, the following resolution was passed unanimously:—'That, cordially approving of the address of condolence presented by the Council to the Queen, and also of the vote of 1,000 guineas from the funds of the society to the National Memorial, the members of the Society of Arts, in this general meeting assembled, are anxious further to record their deep sense of the irreparable loss which the society, in common with the Queen and nation has sustained by the most afflicting dispensation which has deprived it of its illustrious president, the Prince Consort; and this society, being under peculiar obligations to his Royal Highness, whose zealous devotion to its interests was unceasing during the eighteen years of his enlightened presidency, the members desire to testify their estimation of his great services and high qualities by having a special memorial for the society, and that the Council be requested to consider the most appropriate form of the memorial, and bring the matter before a meeting of the members at a fitting time.' The Council have had the foregoing resolution under their consideration, and they recommend that the memorial consist of a bust of his Royal Highness in marble, to be placed in a suitable manner in the great room of the society, and that the funds be raised by subscription amongst the members, and that any surplus funds not required for that object be applied in such manner as the subscribers may direct; and the Council are of opinion that a gold medal, to be called the Albert Medal, should be provided by the society, to be awarded by the Council, not oftener than once a year, 'for distinguished merit in promoting arts, manufactures, or commerce.' It would be a valuable medal—one worth striving for—not a small mark of honour; one which all might be proud to obtain. A medal to be denominated the Albert Medal would be as greatly coveted as the Copley Medal of the Royal Society. That was a medal which was open to men in all branches of science, and of all nations."

The propositions were carried with cordial unanimity.

The President of the Council, in his address to the last general meeting of the society, announces the grant of the "Albert Medal" for the present year, and recalls to the memory of its members the names of the great men whose public services and high merits have been recognised by the award of the "Albert Medal" since its foundation. We extract the following passages:—"The Albert Medal has this year been awarded to Mr. W. Fothergill Cook and Professor Charles Wheatstone, F.R.S., in recognition of their joint labours in establishing the first electric telegraph. It will be remembered that the first Albert Medal was awarded, in 1864, to Sir Rowland Hill, K.C.B., 'for his great services to arts, manufactures, and commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilized world.' The second medal was awarded, in 1865, to his Imperial Majesty the Emperor of the French, 'for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of arts, manufactures, and commerce, the proofs of which are afforded by his judicious patronage of art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects.' The third medal was awarded in 1866, to Professor Faraday, D.C.L., F.R.S., for 'discoveries in electricity, magnetism, and chemistry, which in their relation to the industries of the world, have so largely promoted arts, manufactures, and commerce.' The Council think it right to remind the members of these several awards, in order to keep in their recollection the very high standard of merit which they are intended to mark. In making the award this year, the Council were placed in a somewhat peculiar position, inasmuch as by the terms upon which the medal was established they could only make one award, whilst the great object accomplished was due to the combined labours of two men. They felt, however, that so great a national work as the electric telegraph was especially worthy of reward by this society, and that the Albert Medal could not be more worthily bestowed than in recognition of the services of those to whom the introduction of the telegraph was due. The award having been made, they have directed that the medal be struck in duplicate, and a copy, with a suitable inscription, be presented to each of the above-named gentlemen. The Council feel assured that in selecting the introduction of telegraphy for the award of the Albert Medal, they will have the unanimous concurrence of the members of the society."

ENGINEERING ETC., IN SCOTLAND.

The New Works of the Clyde Trust at Dalmuir.

Amongst the most noteworthy recent undertakings of the Clyde Navigation Trustees, are their extensive works at Dalmuir. For some time past these important ranges of buildings must have caught the attention of steamboat passengers up the river Clyde from Renfrew. They form a good illustration of that judicious foresight and wise liberality which have made the river Clyde and City of Glasgow what they are, and, as they have now nearly reached completion, a few words may be said descriptive of their form and purposes.

The works are situated on the north bank of the Clyde, southwards from Dalmuir Railway Station, and occupy eight acres of ground which were many years ago the site of Messrs. Tennent's chemical works. It is said that the smoke and effluvia from that establishment did so much damage to the crops in the surrounding land, and caused the farmers so vehemently to protest, that the proprietor of the estate would on no account think of renewing Messrs. Tennent's lease, and consequently that firm removed their manufactory to St. Rollox, where they still carry on their prosperous business. After their removal it was rumoured that the chemical refuse which was left at the place was of so powerful and peculiar a nature that it would gradually dissolve whatever it came into contact with, but the foundations of the Clyde Trust works have been guarded to a great depth so as quite to avoid the possibility of any such danger. It is now nearly three years since the building of the works was commenced, and though they are not yet entirely finished, some parts of them have been in active operation for about a twelvemonth, and give a very satisfactory idea of the great benefit and usefulness which may be expected when all the departments are completed. By means of their accommodation and varied appliances at Dalmuir the trustees will be enabled in future to manage for themselves all kinds of repairs and works, instead of being at the disadvantage and additional expense of contracting, as hitherto, with various firms on the Clyde to manage these matters for them. The buildings form a square, and are uniform in their design, the windows and doors on the different sides being equally spaced, and the

various divisions otherwise alike in their general exterior appearance. Some idea of the size of the works may be conveyed by the fact that the two side walls which enclose them, running north and south, are nearly five hundred and fifty feet long, and that on the western side there is a continuous range of buildings to the extent of 347 feet. On the eastern side of the works are the store departments, in three divisions, for oil, oakum, iron, nails, &c. Above this, the drawing loft, on the spacious floor of which new works are mapped out or planned by the draughtsmen, for it should be noted that there is accommodation for devising and making to some considerable extent if necessary, as well as for the more immediate object of repairing damages caused by perpetual wear and tear upon the property of the Trust. The model and pattern lofts terminate the eastern row of buildings, with the exception of a shed—for preserving blocks of timber dry—which stands apart to the south; and below the model loft, and of the same size, is the commodious joiners' shop, with appropriate benches and tools.

Before passing over to notice the western block of buildings, we come upon the slip dock, which intervenes. There is first a small slip about 230 feet in length, for punts, of which there are between three and four hundred belonging to the Clyde Trust. About twenty of these have to be repaired every week. Beyond the punt slip is a much larger one, 427 feet in length, capable of taking up a craft of 1,000 tons. The largest of the Trust's present barges (No. 8) are, however, within 700 tons. The peculiar construction of the vessels for which it is meant, necessitates that this slip should be somewhat uncommon, and it is not only so, but unique and ingenious. In most slips there is a central rail with "ratchets" into which a "pawl" on the cradle works while the vessel is being drawn up from the water, besides two side rails, but in this case the central rail is dispensed with, and, instead, the side rails are provided with "ratchets," which prevent the cradle, with the boat resting on it, from sliding back into the water. This absence of the central rail is made necessary by the fact that the hopper barges and deepeners, for which the dock and slip will be employed, have no bottom keel, but two bilge keels, which allow their bottoms to open out and empty themselves when full of mud or other cargo. The slip is wrought by hydraulic power. The engine for the pumps and the apparatus for this work, which were furnished by Messrs. A. More and Son, of Glasgow, are placed in a house built for the purpose at the north end of the dock. The engine is 40 horse-power nominal, and the hydraulic machine is equal to 800 tons. The portable rods used in the operation are twelve feet in length. The boiler is a "patent two-flue" by Mr. Wm. Wilson, of Lilybank Foundry. The docks on either sides of the slips are capable of holding two or three barges, and on the platform near by stands a crane of 30 tons. Above the ship are well-lighted sheds, where the carpenters have the advantage of working comfortably under cover. A well about 9 feet in diameter is being dug in the northern part of the area, so as to secure an abundant supply of pure water for drinking and cooking purposes. It is being made in the modern and approved style—viz., that of building the wall from the top as the digging and pumping within it proceeded. The water for the ordinary purposes of the work is drawn by suction from the river. Part of the vacant area within the square of workshops is set apart for the storage of buoys, deepening buckets, and timber, of which there is sometimes a stock worth about £2,000 on hand, with an equal value of the best iron. Near the head of the slips there is also found, besides the suite of carpenter's shops, the saw-pit.

Passing now to the northernmost section of the western range of buildings, may be noticed novel plate-furnaces by Messrs. Kelt and Duncan, ironfounders, Partick. By their means a thick plate can be melted to a perfectly soft and pliable state in less than ten minutes with a remarkably small quantity of fuel. In the same section the coals are stored, and here also, for driving the machinery of the works, are the large engines, which, with the boilers, shaftings, and the saw mill, were supplied by Messrs. Wm. Simons and Co., engineers, Renfrew. The machinery of the engine-shop is made and supplied by Mr. Shanks, of Johnstone. The tools fitted here comprise two vertical boring machines—one of them very powerful, having an 18-inch spindle, a slotting machine, an iron planing-machine, and various lathes, and other appliances. The engine used in this division is 60 horse-power nominal. Again, proceeding southwards, or nearer the river, may be noticed the smithy, which is, we believe, one of the largest smithies in the Clyde district, being 160ft. long, and having twenty fires besides two steam hammers (as well as provision for a third, if needed, boring and cutting machines, &c. Next we arrive at the iron-store, and, still further south, at the extreme end of the western buildings, is the division set apart for the making and mending of harbour ferryboats, and other small craft, with a large corner for the repair of buoys. Standing apart from the other buildings, on account of its dangerously combustible contents, is a house for the storage of tar and pitch, while immediately to the north of the entrance-gate is a large apartment which will be used as a dining-room for those connected with the establishment.

There are about 150 men at present employed in the works, and the permanent staff will in future, we understand, be between that number and 200. Besides the eight acres upon which the works stand, the Clyde Trustees have purchased two adjoining acres to the north, upon which it is expected they will soon erect a block of workmen's houses, capable of accommodating 80 families. The works are managed by Mr. Charles Duncan, and have been erected under the superintendence of Mr. Reid, on whom they reflect credit. Mr. W. L. Balfour is the clerk of the works, and to his courtesy and attention in the capacity of *cicerone* we were indebted on the occasion of our visit.

We understand that the Lord Provost and magistrates will shortly pay an official visit to the works.

NOTES ON SHIPBUILDING AND MARINE ENGINEERING ON THE CLYDE.

LAUNCH OF THE "DENMARK," AT RENFREW.

On Thursday, the 15th ult., Messrs. Henderson, Coulton & Co., launched from their building-yard, at Renfrew, an iron screw steamer of about 800 tons, intended for the Danish trade, and named the *Denmark*, of Copenhagen. She was immediately hauled into the builders' tidal basin to receive her boilers and machinery, which are on the compound principle, and are 100 h.p. nominal, with surface condensers. The *Denmark* will be commanded by Captain L. H. Corl, late of the *Phœnix*, built by the same firm, well known in the Danish trade, and to whose order the steamer has been built.

LAUNCH OF THE "JASPER," AT GREENOCK.

On the 17th ult., Messrs. Robertson & Co. launched a three-masted iron schooner for Messrs. McArthur & Co., for the Glasgow, Greenock, and Liverpool trade. She was named the *Jasper* by Miss Edith Mc Arthur. This fine vessel is 125ft. long, 24ft. broad, 16ft. deep, is of 350 tons, and is intended to be classed A A at Lloyd's. She will have steam winches to facilitate loading and discharging cargo. This is the twelfth vessel built for Messrs. McArthur & Co., at Greenock, and the first iron sailing vessel.

LAUNCH OF THE "ONYX," AT POINTHOUSE.

There was launched on the afternoon of the 20th ult., from the building yard of Messrs. A. and J. Inglis, Pointhouse, an elegant iron twin screw steamer of 465 tons, builder's measurement; length, 155ft.; breadth, 25ft.; depth of hold, 8ft.; for Henry A. Hardy, Esq., of Salto, and intended for river traffic on the Uruguay, South America. The vessel was named the *Onyx* before leaving the ways, and was towed up to the harbour immediately after, to receive her machinery, which has been constructed by the builders, at their engine works, Whitehall Foundry.

LAUNCH OF THE "OSSIAN."

There was launched on the 9th ult., from the yard of Messrs. Thomas Wingate & Co., on the Clyde, a screw steamer, named *Ossian*. She is intended for the coasting trade at Campbletown.

TRIAL TRIP OF THE "HANNAH SIMONS."

The new screw steamer *Hannah Simons*, 1,000 tons, just added by Mr. Benjamin Simons, fruit importer, Glasgow, to his fleet of Spanish traders, went down the Clyde on Tuesday, the 6th of August, on a trial trip, which proved highly satisfactory. The *Hannah Simons* is the largest vessel owned in the Clyde engaged in this service.

LAUNCH OF THE "JAQUARETE."

The twin screw steamer *Jaquarete*, launched by Messrs. A. and J. Inglis, on the 18th of July, went down the river on Tuesday the 20th ult., on her trial trip, having on board Benjamin Isaac, Esq., of London, owner of the vessel, and several other gentlemen interested in the South American trade. In running the measured distance between the Cloch and Cumbrae, she attained a speed of 8½ knots. This was regarded as highly satisfactory, considering that the vessel was loaded with 170 tons dead weight of coals and stores. The machinery consists of two pairs of diagonal condensing engines of 50-horse power collectively, one pair applied to each propeller, working independently. The *Jaquarete* will sail for Buenos Ayres in the course of a few days, under the command of Captain McKinnett.

MCHAFFIE'S PATENT MALLEABLE CAST IRON.

In the ARTIZAN of June last we referred to the increasing number and variety of the applications of this metal to manufacturing purposes, and that it is distinguished for its extraordinary durability and immunity from breakage, and that it is being made to serve as a substitute for both wrought iron and steel. In paying a visit the other day to the works of Messrs. McHaffie, Forsyth, and Miller, Glasgow, we witnessed a very important application of this remarkable metal to the construction of cylinders of some large hydraulic cotton presses for India, the length of these cylinders is 13ft., the diameter to suit an 11in. ram, the thickness of metal being only 2½in., which thickness has been arrived at by calculating a pressure of three tons per square inch; this is, however, considerably above the

pressure to be employed, the thickness of metal is greater than would have been used had the actual working pressure been adopted as the basis of the calculation; still, even with the increased thickness, a remarkable contrast exists between it and the thickness considered necessary for an ordinary cast-iron cylinder to do the same work, as the latter would be about 8½in. —an important experiment bearing upon the application of this metal to hydraulic cylinders will also be found cited in our issue for June last. We understand that Messrs. Nasmyth, Wilson, and Co., of Manchester, the engineers, who have ordered the cylinders under notice, have given the preference to this metal after the most careful consideration, and in the knowledge of the frequent breakage of the cast-iron cylinders of cotton presses, which, under any circumstances, a serious enough matter, becomes especially disastrous when occurring in India, so distantly removed from any locality possessing the necessary facilities to make good the damage. It is satisfactory to know that in sending such work abroad the cylinders and other parts of the presses may, when made of this metal, be thoroughly relied upon as capable of withstanding the heaviest strains to which they may be subjected. On the occasion of our visit to the works a piece of the metal was knocked off in our presence from one of a promiscuous collection of articles made from it, and, upon examining the fracture, we were much struck with its resemblance to steel, from the remarkable closeness of the grain.

THE COAL BEDS OF RUSSIA.

The existence of coal in the Oural chain had been long known. The failure of forest wood, previously alluded to, first led to the working of coal mines in these mountains. Coal is found on both sides of the Oural. That on the western slope is of excellent quality, and already twelve large coal beds have been discovered. The mine of Lunieffsky, when worked only to supply a neighbouring iron foundry, yielded 4,800 tons of coal annually, but since 1864 it has supplied in addition nearly 20,000 tons a year to the Samolet Steam Navigation Company, thus showing its capability of meeting almost any demands likely to be made upon it. On the eastern slope of the Oural the coal differs in its most essential characteristics from that on the western. It is found thinly scattered over a waste district, is of inferior quality, loses much of its weight by exposure to the air, breaks up into small fragments, and is hence but ill adapted for transportation. Its local value, however, still remains very great.

In Siberia, the government of Simbirsk, and near Orenberg, coal is to be found. A coal bed in the south of the Crimea was worked for some time, but abandoned as not sufficiently remunerative. In the Trans-Caucasian district, at a point about 175 miles south-west of Tiflis, a coal vein has been discovered eight miles in length, at a depth of from 28ft. to 37ft. below the surface. The coal here is mixed with iron ore, and can be easily worked, but cannot be employed to advantage until the country in which it lies is made accessible by railway. Another valuable coal bed lies under the Moscow and surrounding governments. This bed forms an elliptical basin, of which the greater diameter is 400 miles and the less diameter 266 miles. Near Moscow, which is the centre of the basin, the coal is as much as 1,000ft. below the soil. This, together with the extreme hardness of the strata, renders it difficult to work, so that the mineral is obtained chiefly from the edges of the bed, where it is found much nearer the surface, in strata from a few inches to 9ft. thick. The coal is found to contain 41 per cent. of carbon, and we must not omit the fact, significantly put forward, that it gives out as much gas as coal imported from Scotland for supplying the gasometers. We now come to the most valuable of the Russian coal deposits hitherto discovered. It lies in the government of Ekaterinaslaff and the territory of the Cossacks of the Don, extending as far as the Caspian Sea. Scientific men, both native and foreign, are agreed that coal might be found in abundance in upwards of a hundred places throughout this extensive area. From one district alone 127,300 tons are supplied annually, of which quantity five-eighths are the produce of a single mine. This is the combustible used on board the steamers of the Black Sea Navigation Company. This coal is the only example in Russia of coal deposited during the secondary period, the other beds belonging to the tertiary, and being often of the kind known as brown coal, between strata of sand and clay. In the Don Cossack district the coal varies from the bituminous to the purest anthracite. It is worked at a depth of 280ft. below the surface, is found in layers of which the average thickness is 1ft. 9in., and yields on an average 85 per cent. of carbon. The anthracite is occasionally met with so pure as to give 98 per cent. This coal field will naturally have to supply the railway from Moscow to Odessa, its nearest point being within 120 miles of the line. Unlike the great coal bed round Moscow, it is not distributed in a regular basin, but in a deposit at variable depths, showing frequent and abrupt undulations. From the advantages of its geographical position it is easy to foresee the incalculable importance of the Don Cossack district. Nor is the north of the empire wholly unprovided with fuel for future generations. From the Moscow deposit runs a vein of coal in a north-easterly direction as far as the eastern shore of the White Sea. From time to time some landed proprietor has found himself the fortunate possessor of a coal bed of no mean dimensions. Thus, on the estate of Count P. Schouvaloff, in the Government of Kieff, a bed of coal has been discovered calculated to contain at least 4,000,000 of tons. Again, at Maleafka, in the Government of Taula, the property of Count A. Bobrinsky, a coal bed exists extending over an area of two and a half square miles, and yielding annually 11,000 tons. The discovery of this coal twenty years ago enabled the count to continue the manufacture of beet-sugar, which was at a standstill for want of fuel. Maleafka coal lies in strata which shows a maximum thickness of 21ft., gives 32 per cent. of carbon, and is delivered at the pit's mouth at 7s. 6d. per ton. Though used exclusively for sugar boiling up to the present time, it has been found by experiment to be adapted to heating locomotive engines, and an order from the Taula Railway is now being executed. The cost of the coal when delivered at the railway station will be 16s. a ton, owing to the expense of carriage.

LONDON ASSOCIATION OF FOREMAN ENGINEERS.

The half-yearly meeting of this society took place at the London Coffee House, Ludgate-hill, on Saturday, the 6th ult. The chair was occupied on the occasion by the president, Mr. Joseph Newton, of her Majesty's Mint, and the large assembly-room was well filled. After the minutes of the previous meeting had been read by the secretary, Mr. David Walker, the auditors, Messrs. Dewar and Ross, produced their report and the balance-sheet. Both documents were of a satisfactory character, although the expenditure since Christmas, and especially as regarded allowances to unemployed members, had been unusually large. This item, indeed, amounted to £79; but its magnitude was fully accounted for by the unexampled depression which has prevailed during the half-year throughout every branch of the engineering trade. In this respect, however, it was stated that symptoms of improvement were visible, and the fact that the financial machinery of the association had borne the heavy strain without showing signs of weakness was considered a proof of the stability and value of the institution. After some little discussion the auditors' report was unanimously accepted. From the balance-sheet we transcribe the following summary:—General funds invested in Three per Cent. Consols, £400; invested in savings' bank, £60; cash in Treasurer's hands, £3 9s. 2½d.—total, £463 9s. 2½d. Special fund for superannuation of aged members, £846. The number of ordinary members, foremen, and draughtsmen at present on the books of the society was 105, and that of honorary members, employers, and scientific gentlemen, 53—in all, 158. When these matters were disposed of, the chairman proceeded to make a lengthy and interesting statement as to the progress which had been made by himself and a select committee in the establishment of a scheme of life assurance, by which they hoped to secure the payment of £100 at the death of every ordinary member, as a solatium to bereaved relatives. Eventually the final arrangements for effecting this Christian-like object were entrusted to the general committee of the society. Mr. William Naylor, of the Great East Indian Peninsula Railway, next read a practical paper on the "Construction of Steam Engine Boilers." He confined his attention mainly to locomotives, and illustrated his subject by diagrams, which assisted much in its elucidation. A discussion followed, and this was shared in by Messrs. Keyte, Irvine, Gower, Usher, Miles, Sanson, Vinnicombe, and the chairman. A vote of thanks to the author of the paper, gracefully acknowledged by that gentleman, concluded the proceedings, and the members separated.

Royal Archæological Society.—The proceedings connected with the visit of the above institute to Hull were held in the Reception-room at the Town Hall. The President (Lord Talbot de Malahide) was supported by the Mayor of Hull (Mr. Alderman Loft), the Archbishop of York and Mrs. Thompson, the Bishop of Lincoln, the Dean of York (the Hon. A. Duncombe), Christopher Sykes, Esq., M.P., and many others. The President moved that the Archbishop of York should preside at the meeting. Mr Christopher Sykes, M.P., seconded the motion, which was carried unanimously. The Archbishop of York, after some remarks upon the programme of the meeting, said: I am struck with the moderation of the present race of archæologists in fixing the limits of their science, and in the method which they pursue within those limits. Archæology is a science of the most remote past, but its general description would include the history of languages and study of ancient written records, or palæography. Archæology should be content to separate herself from all these tempting subjects, and to confine herself to the study of the works of human skill, which indicate the growth and social condition of man. A boundary line so artificial is likely to be transgressed from time to time. The charter, chronicle, and will are often appealed to; but they are used not so much for the written thought as for tangible monuments on which they may throw light; and as much for the development of mind they contain, as for the account of things produced by manual skill. The main business of archæology, we are told, is the work of men's hands. For my own part, I would venture to submit that in studying all the materials of history, archæology would do better still. The meeting was afterwards addressed by the Bishop of Lincoln and others.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

The last ordinary monthly meeting of the Executive Committee of this Association was held at the offices 41, Corporation-street, Manchester, on Tuesday, July 30th, 1867, William Fairbairn, Esq., C.E., LL.D., F.R.S., &c., President, in the chair, when Mr. L. E. Fletcher, chief engineer, presented his report, of which the following is an abstract:—

"During the past month 272 visits of inspection have been made, and 624 boilers examined, 392 externally, 6 internally, 11 in the flues, and 215 entirely, while in addition 4 have been tested by hydraulic pressure. In these boilers 170 defects have been discovered, 6 of those being dangerous.

'Tabular Statement of Defects, Omissions, &c., met with in the Boilers examined from June 22nd to July 26th, 1867, inclusive.

Description.	Number of Cases met with..		
	Dangerous.	Ordinary.	Total.
Defects in Boiler.			
Furnaces out of Shape	...	7	7
Fracture	3	21	24
Blistered Plates	...	13	13
Corrosion—Internal	1	15	16
Ditto External	2	20	22
Grooving—Internal	...	18	18
Ditto External	...	1	1
Total Number of Defects in Boilers ...	6	95	101
Defective Fittings.			
Feed Apparatus out of order	...	2	2
Water Gauges ditto	...	7	7
Blow-out Apparatus ditto	...	11	11
Fusible Plugs ditto	...	...	...
Safety Valves ditto	...	7	7
Pressure Gauges ditto	...	17	17
Total Number of Defective Fittings ...	...	44	44
Omissions.			
Boilers without Glass Water Gauges	...	4	4
Ditto Safety Valves	...	...	...
Ditto Pressure Gauges	...	...	...
Ditto Blow-out Apparatus	...	6	6
Ditto Feed back pressure valves	...	13	13
Total Number of Omissions	...	23	23
Cases of Over Pressure	...	...	...
Cases of Deficiency of Water	...	2	2
Gross Total	6	164	170

It will be seen on reference to the preceding return, that a high number of entire examinations is still maintained, as many as 215 boilers out of the 624 inspected during the past month having been examined entirely, that is to say, internally as well as in the flues. It is on these entire examinations that the Association relies more especially for the prevention of explosions, and therefore attaches considerable importance to their increasingly high number. This is greatly due to the working of the guarantee system, which makes an annual entire examination of every boiler an essential condition of granting the guarantee.

The defects met with, however, during the past month were of an ordinary character, and do not present any features of sufficient interest to merit detailed reference.

Explosions.

Explosions are not occurring with the same rapidity this year as in many previous ones; and on the present occasion, as in the preceding month, I have but one explosion to report, which occurred to a boiler under the inspection of this Association.

No. 16 explosion is an illustration of the danger of setting boiler on mid-feathers, especially when the boilers are of large diameter. This explosion which resulted in the death of two persons, as well as in injury to two others, occurred at a woollen mill, at twenty minutes after eight o'clock on the morning of Thursday, July 11th, when the engine was at rest during the breakfast time.

The boiler was one of a series of three set alongside of the mill, and parallel with it, all of them being internally-fired, and worked at a pressure of about 30lbs. on the square inch. The exploded boiler, which was the inner one of the series, and set nearest to the mill, was one of the Cornish class, having a diameter of 9ft., a length of 26ft., and being made of plates seven-sixteenths of an inch in thickness, while the internal tube, which ran through the boiler from one end to the other, measured 5ft. in diameter at the furnace end, and tapered down to 4ft. behind the fire bridge.

The boiler gave way in the external shell, the primary rent occurring at the bottom, where it came in contact with the mid-feather wall, on which it rested. This primary rent extended longitudinally for a length of about 10ft., when at each end of this line it assumed a circumferential direction, running more than half way round the boiler, and in this way severing from the shell a tongue or partial belt, consisting of five widths of plate, and situated nearly midway between the two ends of the boiler. This tongue was opened out nearly flat, and the boiler thrown forward some 50ft. from its original position, passing on its way through a four-storied house, which it brought to the ground, while, in addition, a considerable portion of the mill, close to which the boilers had been set, was blown down, the adjoining boiler in the series thrown from its seat, the boiler-house laid in ruins, and the mill brought to a standstill.

The cause of this explosion I found, on visiting the scene of the catastrophe, and examining the fragments of the exploded boiler, to be apparent at a glance. The edges of the plates, at the primary line of fracture, which had run along the mid-feather wall, were seriously reduced in thickness by external corrosion, being eaten away to the thickness of one-sixteenth of an inch, while in some places they were as thin as a sheet of paper, so that the wonder is, not that the boiler exploded when it did, but that it had not done so long before. A careful flue examination by a competent inspector would have shown the dangerous state of this boiler in time to have prevented the explosion.

Evidence to this effect was given at the inquest; a scientific witness stating that "the explosion was not attributable to deficiency of water, but solely to extensive corrosion of the plates on the underside, caused by leakage of the seams, and dampness of the brickwork, which was a well-known source of danger, and ought to have been guarded against." The jury brought in a verdict of "Accidental Death," adding, however, that the owner of the boiler, as well as the person who had charge of it, were censurable for the explosion, though not criminally responsible, while the foreman took the opportunity of recommending that every millowner should have his boilers periodically examined.

On this occurrence of another fatal explosion to a boiler resting upon a mid-feather wall, the members of the Association may be once more appealed to to discontinue so dangerous a mode of setting, and to adopt side walls with suitable seating blocks instead. This latter plan is superior on many grounds. If the flues are damp the moisture rises more readily through the mid-feather than through the side walls, as there is in most cases less height of brickwork in the former for it to travel through. Also any water that may either fall on to the boiler or leak from the seams, is more liable to lodge in contact with the plates on the top of the mid-feather than on the side walls, the bearing surface of the mid-feather being at the bottom of the boiler, so that it collects all the drainage, and being horizontal so that it retains it, while that of the side walls is inclined and thus affords the water an opportunity of escaping. It is not thought, however, that the corrosive tendency of moisture is the only cause of the injurious effect of mid-feathers, but that it is materially promoted by mechanical action. A boiler does not "ride" so comfortably on a single longitudinal seating as when carried on two, and when the weight of a large boiler is thrown entirely on a mid-feather, a change of form frequently takes place with every change of pressure. This has been distinctly observed on the application of the hydraulic test, the internal pressure raising the boiler, while it might no doubt be seen in some cases on getting up steam. In making internal examinations of boilers set on mid-feathers, the plates at the bottom of the shell are not unfrequently seen to be flattened all the way along at the centre line, so that the mid-feather can be distinctly traced even inside the boiler. It will thus be seen that an alternate flattening movement is carried on throughout the line of the mid-feather wall on every variation of internal pressure, which tends not only to strain the ring seams of rivets and make them leak, but by its buckling action to "fatigue" the metal, and thus very much to accelerate the ravages of corrosion from moisture upon the body of the plates, so that a mid-feather wall may be said to produce a description of longitudinal "furrowing" along its bearing surface.

This will show the importance of the recommendation constantly made to those members who have boilers set on mid-feather walls, that they should have the brickwork ploughed out at the transverse seams of rivets for purposes of inspection. Without this it is impossible to ascertain the condition of the plates, since, although they may appear perfectly sound on each side of the mid-feather wall, especially if it be a wide one, may yet be dangerously wasted in a longitudinal "furrow" all along the centre line. These openings need not be large; it will be sufficient if they are about 9in. long by 3in. high, and cut completely across the wall, so that if a light be held on one side they can b

seen through. They need not be permanently filled up after an inspection, but merely stopped temporarily with a little fire-clay, so as to be easily re-opened whenever re-examination is necessary.

To prevent any mistake as to the size of these openings or pockets, the following sketch is appended, which it is thought will make the matter perfectly clear.

In conclusion, it is earnestly recommended that no boilers, having a diameter of 5ft. and upwards, should be set on mid-feather walls, but if in the case of small boilers, and under exceptional circumstances any of these walls should still be adopted, then the boilers should rest on suitable seating blocks, instead of on bricks; while the bearing surface should not exceed an inch in width for every foot in the diameter of the boiler, and sight-holes, as explained above, should be ploughed out at each of the ring seams of rivets.

FATAL EXPLOSION OF A HOT WATER BOTTLE.

This explosion took place on the 31st of March, and though it cannot rank either among those of steam-boilers or household ones, yet, as it resulted in the death of one person, as well as in serious injury to two others, it is of importance socially; while, independently of its effects, it is of interest in a scientific point of view, and, therefore, the particulars of this explosion may be given, though it occurred only to a hot water bottle.

The bottle in question was of earthenware, of about a quart capacity, and used when full of hot water as a bed warmer. It had been put to this service on a previous occasion, when the cork had been tied in with a waxed end, such as is commonly used in shoemaking. When the bottle was wanted again for a similar purpose, instead of being emptied of its cold water and refilled with hot, it was put, all tightly corked, into the oven of a kitchen range, to be heated up entire. In a short time a violent explosion ensued, the bottle was burst in pieces, a corner of the oven door split off, and the fragments of iron and earthenware thrown into the room with so much force that three persons were seriously injured, one of them, a child, dying the day after.

This explosion, though calculated from its simplicity to provoke a smile, is in an engineering point of view of considerable interest, and involves important principles. The explosion of household boilers is always attributed to the water supply being allowed to run short, and then suddenly re-admitted on to red-hot plates, which is supposed to be productive of a wonderfully disruptive force; while with regard to explosions generally, it is too frequently thought that a gradual accumulation of steam is insufficient to produce the disastrous results attendant upon them, which are therefore attributed to some sudden generation of pressure from the detonation of gases or other imaginary cause; while others again hold the opinion that no boiler can explode if suitably supplied with water, and that though it might rend, it would do so without violence. There is no getting away, however, from the facts of this explosion, its simplicity renders it most convincing. There was no pipe to suddenly re-admit the feed, as in the case of the household boiler, on to the supposed hot plates, while the circumstances forbid the explosion's being attributed to any other cause than quiet internal pressure from the gradual accumulation of steam, which, it will be seen, did not quietly rend the bottle, but violently exploded it. This little incident supports the views expressed in the Association's report for January, 1867, relative to the explosion of household boilers, viz., that they were due simply to the gradual accumulation of steam, and might be prevented by an efficient safety-valve.

ROYAL GEOGRAPHICAL SOCIETY.

THE PRESIDENT'S ADDRESS.

Gentlemen,—I meet you with the satisfactory announcement that great as was the number of our members at the last anniversary, it has since then considerably increased, and now amounts to 21,20 Fellows.

I have also the satisfaction of reminding you that, thanks to the zealous and efficient services of our assistant secretary, Mr. Bates, the well-filled volume of the year has been, like the last, for some time in your hands.

The general observations on the progress of geography which I shall lay before you in the following address will, as usual, be preceded by brief notices of those of our deceased associates who have taken any part in geographical researches or publications, as well as by a review of the Admiralty Surveys prepared by Capt. Richards, the hydrographer.

OBITUARY.

In justice to an eminent geographer who has been taken from us, I begin the sad record (much less heavy, however, than that of last year), a notice of the career of

Sir George Everest.—This distinguished Indian surveyor and geographer was the son of Tristram Everest, Esq., of Gwernvale, Brecon, and was born on the 4th July, 1790. He began his scientific education at Marlow and completed it at Woolwich, where he passed a brilliant examination, and was declared fit for a commission at an earlier age than the limit fixed by the regulations. Sailing for Bengal as an artillery cadet in 1806, the first important service in which he was engaged was in executing a reconnaissance survey of the Island of Java, for which duty he was selected by the famous Sir Stamford Raffles, during the occupation of the island by the British from 1814 to 1816. During this period Everest gained the friendship of our honoured associate Mr. John Crawfurd, who, happily, is still amongst us, after a distinguished career in the East, particularly in connection with the Malay Archipelago.

On his return to Bengal, Everest was employed by the Government in various engineering works, particularly in the establishment of a telegraph system between Calcutta and Benares. It was not long, however, before he entered upon a service of more immediate connection with geographical science; for in 1818 he was appointed chief assistant to Colonel Lampton, the founder of the Great Trigonometrical Survey of India. It will not be considered out of place here, if I mention that this colossal undertaking owes its origin to the late Duke of Wellington, who recommended it and gave it his cordial support, selecting Colonel Lambton to carry it out. How much an accurate survey was needed was shown by the earlier results of the operations, an error of 40 miles being detected in the breadth of the peninsula as previously laid down.

Captain Everest was first employed in the triangulation of the eastern part of the Nizam's dominions, where the unhealthy climate and close application to his duties so affected his health that he was ordered to the Cape of Good Hope to recruit. He did not, however, remain idle, for he employed his leisure in investigating the circumstances appertaining to the Abbé de la Caillé's arc, and his researches formed the subject of paper, published in the first volume of the "Transactions of the Astronomical Society."

On the death of Colonel Lambton, in 1823, Captain Everest succeeded to the vacant post of superintendent of the great survey. He applied himself with such unremitting ardour to the extension of the great arc series of measurements, that his health again gave, and he was obliged to seek rest and change for a time in England.

In 1830 he returned to India, provided, by the liberality of the Court of Directors, with an equipment of geodetical instruments and apparatus for the continuance of the survey, in the construction of which the most skilful makers had been employed. He had made himself acquainted during his visit with the English Ordnance Survey system, and with every modern improvement in geodetical matters that had taken place in Europe. Thus provided, and in the prime of life, Colonel Everest returned to his great task. In addition to the duties of Superintendent of the Trigonometrical Survey, he had now to perform those of Surveyor-General of India, to which office he had been appointed by the Court of Directors; a union of offices which vastly increased his labours.

Between the years 1832 and 1841 the measurements of the great arc were carried on, and in December of the latter year closed by the completion of the Beder base-line, a work accomplished by his chief assistant, Captain (now Sir Andrew Scott) Waugh. The whole Indian arc from Cape Comorin to the Himalayas was thus completed. These elaborate operations are fully detailed in Colonel Everest's work on the "Measurement of two Sections of the Meridional Arc of India," published in two quarto volumes in 1847; a work which gained for its author a high reputation.

In summing up the labours of Sir George Everest I cannot do better than quote the expressive words used when the Asiatic Society of Bengal nominated him an honorary member. "Of the many works executed under Colonel Everest's direction, the most important, and that by which he will be best known to posterity, is the northern portion of the great Meridional Arc of India, $11\frac{1}{2}°$ in length. No geodetic measure in any part of the world surpasses, or perhaps equals, in accuracy this splendid achievement. By the light it throws on researches into the figure and dimensions of the earth, it forms one of the most valuable contributions to that branch of science which we possess, whilst, at the same time, it constitutes a foundation for the geography of Northern India, the integrity of which must for ever stand unquestioned. Colonel Everest reduced the whole system of the Great Trigonometrical Survey of India to order, and established the fixed basis on which the geography of India now rests."

After Sir George Everest's departure from India in December, 1843, and retirement from the service, his successor, Sir Andrew Scott Waugh, took an opportunity of paying a well-deserved compliment to his former commanding

officer, by naming after him the highest mountain measured in the Himalayas—namely, Mount Everest, whose height is 29,002 feet.

At the conclusion of his active career in India, and on settling in England, it was quite natural that all scientific societies should have wished to do honour to such a man. He therefore naturally became a fellow of the Royal Society, an active supporter of the Royal Institution, but especially was he appreciated by geographers, inasmuch as he was for many years one of our most honoured associates in the council of this society, and one of the most distinguished scientific geographers who ever held the office of vice-president.

Professor Henry Rogers was a distinguished geologist of the United States, who for the last years of his life became quite naturalised among us, and was, indeed, Professor of Natural History in the University of Glasgow at the time of his death.

His chief work, entitled "The Geology of Pennsylvania, with a General View of the Geology of the United States," in 3 vols. 4to., was illustrated by so well defined a map of the whole region of the United States that even in this Society his name must be ever mentioned with respect.

Besides the delineation of the boundaries of all the principal geological formations in the States, his sections are most ably drawn in showing how the strata of the Apalachian chain have been folded over and over, and how the whole have been violently affected, and in many cases reversed in their order, particularly in contact with igneous and metamorphic rocks of the eastern seaboard.

The Rev. George Cecil Renouard, Rector of Swanscombe, near Rochester, who died on the 15th February last, in his eighty-seventh year, was one of the oldest Fellows of our Society, and during ten years (1836 to 1846) acted most efficiently and zealously as foreign secretary. In early life, after leaving Cambridge, he fulfilled the duties of chaplain to the British embassy at Constantinople; and, after an interval in England, went back to Turkey as chaplain to the Factor at Smyrna, which appointment he held to 1814. On returning to Cambridge he was elected Professor of Arabic in that University. His acquaintance with the geography and languages of the East rendered him a most leading and useful member of the Asiatic and Geographical as also of the Syro-Egyptian and Numismatic Societies.

In regard to his incessant labours to correct and improve all the publications in our volumes which related to comparative geography or to Asiatic and African subjects, I can bear full testimony that this good and learned man laboured successfully for others in the advancement of knowledge without looking for praise or endeavouring to gain any reputation for himself. As an editor his perspicuity was invaluable, as shown by all the papers on classical or critical geography which passed through his hands.

His kindly manners and true modesty endeared him to every one of the council with whom he acted, and when he spoke on any moot point, he was as logical in his deductions as he was accurate in his facts.

An excellent parish priest, he united the utmost purity of life with a simple and guileless nature, chastened by a feeling of reverence as deep as it was real; for, disliking metaphysics, he always maintained that Faith has its own high region, whither Reason cannot follow it.

Sir Stuart Donaldson, who died on the 11th of January, 1867, was brought up to commercial pursuits, his brother, the late Dr. Donaldson, head master of the school at Bury St. Edmunds, having been one of the most accomplished scholars of our day. At an early age he went to Mexico, where he remained some years, and acquired a knowledge of the Spanish language, which he spoke with fluency. About the year 1830 he went to Australia, and was engaged at Sydney as a merchant for many years.

On the establishment of Representative Institutions in the colony he became a member of the Legislature, in which, being a ready and successful speaker, he took a prominent place. When responsible government was set up in the Australian colonies (1856) he became Colonial Treasurer, and on his return to England, in 1859, he received the honour of knighthood. Among his good deeds he is to be remembered as one of the original members of the Senate of the University of Sydney, in the foundation and conduct of which he took, as I am informed by Sir Charles Nicholson, a very important part, as well as in other colonial establishments.

When he came among us here, we who knew him became soon attached to him, for his warm, cheerful, and genial manner; whilst at our convivial parties his fluency and energy as a speaker will be always remembered. In short, both in Australia and at home, this open-hearted, generous man has left many friends to deplore his loss in the prime of life, and when he was striving to obtain a seat in the British Parliament.

It is not within my province to endeavour to do justice to the various claims which many other deceased Fellows have unquestionably had to public recognition, irrespective of geographical science and researches. A mere enumeration, however, of the names of those who have been taken from us, many of whom were of high reputation in other spheres, will indicate how well the Royal Geographical Society is supported by men of all classes in the British dominions. In this melancholy list are the following:—The Marquis of Camden, K.G., D.C.L., one of our original members; the second Marquis of Lansdowne, son of our much lamented founder; Lord Northbrook, well known as Sir Francis Baring, M.P., who, when First Lord of the Admiralty, was a good supporter of Arctic exploration and Lady Franklin's efforts; Mr. T. Alcock, formerly M.P.; Mr. Joseph Beldam; Mr. Charles Bathoe; Captain John Chapman, R.A.; Mr. Daniel Clark; Mr. John Dobie, R.N.; Mr. George Dollond; Mr. Peter Dickson; Sir Alexander P. Gordon-Cumming, Bart., of Altyre; Mr. J. Gilchrist; Mr. Charles Pascoe Grenfell, many years M.P.; Mr. Robert Carr Glynn; Major J. F. Napier Hewett; Mr. Jacob Herbert; the Rev. C. Hudson, the ardent Alpine explorer, who lost his life on the Matterhorn; Mr. F. S. Homfray; Mr. R. Hanbury, M.P.; Captain Clement Johnson; Commander Jones-Byrom, R.N.; General Sir Harry Jones, G.C.B., a highly distinguished officer of Engineers, and lately Governor of the Royal Military College; Mr. C. H. C. Plowden; Mr. Thomas Phinn, Q.C., formerly M.P., and latterly Judge Advocate of the Fleet, and Councillor of the Board of Admiralty; Major Patrick Stewart, distinguished for his engineering services under Lord Clyde in the Indian war, and also in the laying down of the great telegraphic lines through Persia to Hindostan; Mr. J. F. Pike Scrivener; Mr. H. S. Dazley Smith; the Rev. W. Brownrigg Smith, M.A.; Mr. John Stewart; Mr. Alexander Trotter, the brother of the lamented explorer of the Niger; Mr. John Taylor; Mr. Thomas Vardon; Mr. C. Willich; and the Right Hon. John Wynne.

Admiralty Surveys.*

The Admiralty Surveys both at home and abroad have been carried out during the past year with energy and success, and the results compare favourably with those of any preceding year. The following sketch will convey an idea as to how the force has been distributed, and the amount of work which has been accomplished.

Coasts of the United Kingdom.—Captain E. J. Bedford, with his three assistants in the *Lightning*, have been employed in the Bristol Channel. They have completed a new survey of Cardiff Roads and its approaches on a scale of four inches to the nautical mile, and have done much towards correcting the chart of the upper portion of the Channel in the vicinity of the Welch Grounds, where great changes had been found to have taken place since the surveys of 1847-9. This work is still in progress.

Staff-Commander E. K. Calver, with his two assistants in the *Porcupine*, has been employed in making a minute examination of the eastern coasts of the United Kingdom, with a view to correcting the charts and revising the sailing directions to meet the constant changes which are occurring on these shores. Five hundred and thirty miles of coast between Cape Wrath, the north-westernmost point of Scotland, and the River Humber, have been so examined, and the entrances of the rivers Tay, Blyth, Tees, and Humber, where very considerable changes were found to have taken place, have been entirely re-surveyed. During the progress of this work a dangerous sunken ledge off Tarbet Ness—the promontory which separates the Dornoch Firth from the Bay of Cromarty—has been discovered and placed on the charts.

Channel Islands.—Staff-Commander John Richards, with one assistant, has completed the coast-line of the Island of Jersey, and has constructed on a large scale a plan of St. Helier's Bay, to enable the island authorities to improve and extend their present limited harbour accommodation.

The exceptionally rocky nature of the shores of the Channel Islands, the many off-lying dangers, the strength of the tides, and the general intricacy of the navigation, render the progress of this important survey necessarily slow, and much remains to be done before we can supply a complete and satisfactory chart of the whole group with their approaches. Surveys of most of the islands, however, are already separately published.

Portsmouth.—A small party with a steam launch has been employed on the Bar, Spithead, and its neighbourhood, during the past year. The deepening of the entrance by artificial means, and the numerous works in progress, have rendered it necessary that a constant watch should be kept to detect the least changes which may possibly take place. Commander Brooker, in conjunction with Mr. Hall, Master R.N., which latter officer succeeded in August last to the charge of the survey, has made a minute examination of the Bar on a scale of 60in. to the mile; and it is satisfactory to find that the extra depth of between 6ft. and 7ft. water, which was obtained by dredging two years since, is fully maintained.

Foreign Surveys.—Mediterranean.—The *Hydra*, under Captain Shortland, has been employed during the past season in making a new survey of the Malta Channel, which has involved a minute triangulation of the south and east coasts of Sicily, the accurate determination of the various shoals, with elaborate soundings. This work is still in progress, and, it is hoped, will be completed during the present year.

China Sea.—This survey, which is under the charge of Mr. J. W. Reed, Master R.N., in the *Rifleman*, extends from the Equator to the parallel of Hong Kong, including the various passages southward and eastward of Singapore, together with the main and Palawan routes. The whole region is encumbered with innumerable reefs and shoals, and although very much has been done towards determining their true positions by the many eminent surveyors who have been for years employed by the Admiralty on this service—no less important to all maritime nations than to Great Britain—much still remains to be completed before we can consider the routes to China free from danger.

Mr. Reed and his officers have been profitably employed during the past year in examining the reefs and shoals in the main route. They have surveyed the St. Esprit Shoal, between the Paracels and Hong Kong, the Fiery Cross, or Investigator Reef, off the North-west Coast of Borneo, and determined the true positions, or expunged from the Chart those of many other hitherto doubtful dangers.

North China and Japan.—It was stated in our last annual report that the *Swallow*—employed for four years on this survey—was on her way to England, and was to be relieved by another vessel. The *Sylvia*, under Commander Brooker, has since left England on this duty. The survey comprises a very extensive field of new, or, at any rate, little-known ground, towards which trade is now rapidly advancing.

The labours of the surveyor have always been, and always must be, the precursor of commerce; and Japan, Formosa, the Korea—the islands of the Eastern Archipelago—will long afford scope for his energy and talent. The vast Empire of Japan, indeed, has the outline of its shores fairly represented on our charts upon the authority of its own ingenious geographers, and its principal ports to which we are at present admitted have been surveyed by ourselves; but there is still a void which the annual record of disasters too clearly confirms, and which, if ancient custom is adhered to, it will remain for us to fill up. As to the Korea, it is at present almost a sealed book.

* By the Hydrographer, Captain G. H. Richards, R.N.

The *Serpent*, a ship of war under the orders of the Commander-in-Chief in China, commanded by an able surveying officer, Commander Bullock, performs also the duties of an auxiliary surveying vessel when necessary, or the exigencies of the service will admit; and many valuable contributions to the hydrography of the China Seas have been received from Commander Bullock, more especially connected with the coasts of Japan.

Straits of Magellan.—It was also stated in our last report that in withdrawing the second vessel from the Mediterranean survey now approaching completion, it was the intention of the Admiralty—considering the importance of this strait as a line of steam communication between the Atlantic and Pacific Oceans, and the comparatively little that was known of those extensive channels leading northwards into the Gulf of Penas from its western entrance—to undertake a thorough examination of this region. The *Nassau*, commanded by Captain Mayne, sailed accordingly from England on this service in the fall of the past year, and, from our latest information, had commenced her work under favourable circumstances and with the cheerful co-operation of the Chilian Government.

West Indies.—This survey, which is carried on by hired vessels and boats, has been in abeyance during the last year, owing to the officers who had been many years employed on it having returned to England. It has, however, been resumed under its former commanding officer Mr. Parsons, Master R.N., who, with two assistants, now commence the Surveys of Barbadoes and Montserrat.

Bermuda.—A small surveying party, under Mr. Langdon, Master R.N., has been for some time engaged in sounding the various channels between the reefs of this group, the increased draught of water of our ships rendering diving operations occasionally necessary to remove coral patches.

The *Gannet*, a ship of war on the West India Station, commanded by an experienced surveying officer, Commander Chimmo, is also engaged in surveying operations, when other duties will permit. Commander Chimmo has, during the past season, completed the survey of the Gulf of Paria and other portions of the Island of Trinidad, and made large plans of the entrance known as the "Serpent's Mouth," and the anchorage of San Fernando.

The *Gannet*, and gunboat *Minstrel*, under Commander Chimmo, assisted by Mr. Scarnell, Master R.N., have completed the soundings of the Bay of Fundy, and thus brought to a close the survey of Nova Scotia.

Newfoundland.—This survey, under Mr. J. H. Kerr, Master R.N., and carried on in a hired vessel, has made steady progress during the last year. Mr. Kerr and his assistants also rendered essential service to the expedition which laid the Atlantic cable of 1866, by buoying the course of the cable, and by piloting and assisting with their local knowledge the squadron which assembled in Trinity Bay on that occasion.

British Columbia.—Mr. Pender, Master R.N., in charge of this survey, with two assistants, has been employed during the past year, with a hired vessel, in surveying the intricate and hitherto little known channels between the north end of Vancouver Island and the northern boundary of the British possessions, in 54° 40′ N. lat., and has made good progress with this work; he has also surveyed the bar and harbour at the eastern entrance of the Skiddegate Channel in Queen Charlotte Island, as well as made plans of several useful anchorages, not before known, on the shore of the mainland. The bar at the entrance of the Fraser River has also been re-surveyed, in consequence of material changes which had occurred in the depth and direction of the channel.

Cape of Good Hope.—The survey of the shores of this colony has rapidly advanced towards completion under Staff-Commander Stanton during the past year; and, with the assistance of H.M.S. *Rapid*, Commander Stubbs, afforded him by Commodore Caldwell, the soundings between Storm River and Cape Reciffe have been satisfactorily completed.

Colonial Surveys.—Victoria.—Captain Cox having retired from the charge of this survey, after a long and useful service of more than thirty years in the surveying branch of the profession, has been succeeded by Commander Wilkinson, who, with his assistants, during the past year, has made considerable progress in the survey of the exposed outer coast of this part of Australia—having completed from Port Phillip westward to within a league of Cape Otway. The Government of Victoria have wisely placed the colonial steamer *Victoria* at Commander Wilkinson's disposal for this duty during the last few months, the advantage of which over the former system of working in a small sailing-vessel is apparent in the increased progress of the survey; and should it be found practicable to continue this advantage to the surveying officers, we may expect at no distant time to have the whole seaboard of this colony completely and satisfactorily surveyed.

New South Wales.—Captain Sidney, in charge of this survey, has, with his two assistants, made very good progress during the past year. The coast between Sydney and Port Stephens, a distance of 86 miles, has been very carefully examined and charted. A re-survey of the harbour of Newcastle, rendered necessary by the changes in the banks and channels, has also been made, and the harbour of Port Stephens has likewise been completed.

Queensland.—The progress of the regular survey of the coasts of this colony has been somewhat interrupted, owing to changes among the officers; Staff-Commander Jeffery has retired from the charge of the survey, and his assistant been transferred to another colony. Mr. Bedwell, Master R.N., has succeeded to the charge, and without any assistant has completed 60 miles of the shores of Moreton Bay, and sounded over 180 square miles of ground.

Any loss of time, however, which has been sustained through the causes above named has been more than compensated for by the energy and ability of Commander Nares, of the *Salamander*, who, while employed on special service between Brisbane and the new settlement of Somerset at Cape York, has lost no opportunity of adding to our hydrographical knowledge of those parts of the eastern coast of Australia which had only been partially examined before; and since our last report Commander Nares has surveyed the eastern coast of Hinchinbroke Island, the Palm Island Group, and Cleveland Bay.

The examination of the southern and eastern shores of the Gulf of Carpentaria by the *Salamander* was postponed during the last season from press of other duties, but it has probably been carried out ere this.

South Australia.—The little vessel employed on the survey of the coast of South Australia had, as stated in our last year's report, been transferred for a very considerable time, at the request of the Colonial Government, to the north and north-western coasts of Australia in connection with the formation of new settlements. Latterly Mr. Howard, Master R.N., who was in charge, together with his assistant, Mr. Guy, have been able to add considerably to our knowledge of these shores, and have charted the coast between Cape Croker, the north-east point of Coburg Peninsula and Cape Stewart, a distance of 250 miles. All this coast has been fairly sounded and several new dangers accurately determined and laid down, as well as detailed plans made of Mountnorris Bay and the Liverpool River. The vessel has now returned to Adelaide, and Commander Hutchison, having resumed the charge of the survey, has commenced his work on the eastern side of Spencer Gulf, 70 miles of the coast of which, southward of Cape Elizabeth, including a plan of Port Victoria, have been already completed.

Summary.—During the year 1866 sixty-eight new charts have been engraved and published, noteworthy among which is that showing the Agulhas Bank and the coast of the Cape of Good Hope from Hondeklip Bay to Port Natal. Upwards of 1,050 original plates have been added to and corrected, and 168,900 charts printed.

Sailing Directions for the approaches to the China Sea and Singapore, by the Straits of Sunda, Banka, Gaspar, Carimata, Rhio, Varella, Durian, and Singapore, as well as the annual light books, tide tables, and azimuth tables have been published.

Continental Publications.

Independently of the societies established in many of the capitals of Europe for the promotion of Geographical Science, the chief source of information has been, as in former years, Perthes' "Geographische Mittheilungen," so ably conducted by our honorary associate, Dr. A. Petermann. Although the past year appears not to have been remarkable for any great discoveries in our science, many memoirs of considerable interest have been published in this important serial. Amongst those more especially deserving of mention is an article entitled "Das Nordlichtse Land der Erde" (1867, Part v.), which contains a *resumé* of the geographical and cartographical results of all the North Polar Expeditions in the neighbourhood of Baffin's Bay from 1616 to the last journey of our medallist, Dr. Hayes, in 1861. The paper is illustrated by an excellent comparative map, which gives a clear view of the successive additions to our knowledge of this portion of our Arctic regions. A memoir by the well-known Siberian explorer and naturalist, M. Radde, is also well worthy of especial mention, describing the chief results of his travels and botanical researches in the Caucasus in the year 1865. This, together with a memoir by Otto Finsch, "On the Geographical Distribution of Parrots" ("Mittheilungen, 1867, Part i.), illustrated by a map, coloured to show the ranges of the genera and families, furnish striking examples of the close connection of botanical and zoological distribution with our favourite science. Other papers worthy of attention are Payer's "Investigation of the Ortler Alps," Colonel E. von Sydow's View of European Cartography in 1865 and 1866; an article by the learned editor, advocating warmly the establishment of a German society for the promotion of geographical expeditions; and, lastly, "Altitude measurements of the Rocky Mountains in Colorado Territory," in which it is shown that Pike's Peak and other culminating points are exceeded in height by peaks in the Sierra Nevada range of California, as measured by the geological survey of that state.

Grundemann's Missionary Atlas.—A special atlas devoted to the illustration of the geography of Protestant missions, and compiled by Dr. Grundemann, is now in course of publication, in German and English editions. The first parts, containing maps of several districts on the west coast of Africa, have already appeared, and the work seems likely to prove very useful to all those who are interested in the progress of missions in little-known parts of the world, especially as the maps contain much detail, and are in a convenient and portable form.

Africa.

Dr. Livingstone.—During the last few months our thoughts have been directed, with painful interest, to the last enterprise of our eminent associate, Livingstone. For reasons which I have explained at our evening meetings, and also through the public press, I have never admitted that there existed any valid proof whatever of the death of that great traveller. And now that Arab traders have arrived from a spot close to the reported scene of the murder, long after the event was said to have taken place, and brought to the Sultan of Zanzibar the intelligence that he passed safely into the friendly Babisa country to the westward, and that a report has arrived at Zanzibar that a white man had reached the Lake Tanganyika, we have fresh grounds for hoping that he may now be pursuing his journey into the interior. In truth, we have recently obtained good evidence of the mendacity of the man Moosa, on whose statement alone the death was reported—it being known that he has given one version of it to the consul and Dr. Kirk at Zanzibar, and also to the British resident at Johanna, and an entirely different one to the Sepoy examined, on his return to Bombay, by Colonel Rigby. We have the strongest grounds for disbelieving the story altogether, and for hoping that our great traveller has passed safely through the intermediate country and reached the Lake Tanganyika, the great object of his mission.

Already Livingstone, by crossing the northern end of his own Lake Nyassa, has determined one important point in respect to the watershed of South Africa, for he has proved, according to Dr. Kirk, that this great sheet of water here terminates, and is not connected with the more northerly Lake Tanganyika. If he has been spared, as we all hope, he has before him as grand a career as was ever laid out before an African explorer, it being now probable that Tanganyaik

a fresh-water sea which must have an outlet, is connected on the north with the Albert Nyanza of Baker and others belonging to the Nile system. For although Burton and Speke estimated the height of Lake Tanganyika to be little more than 1,800 feet above the sea—the Albert, or lower lake being, according to Baker, 2,720 feet—many persons, mistrusting the results obtained by the use of a bad thermometer, still think it probable that the Tanganyika may communicate through a gorge in the mountains at its northern end with the Albert Nyanza of Baker; for both these waters lie in the same meridian.

Pursuing this subject, our associate, Mr. Findlay, after a comparison of the altitude observations ot Burton and Speke, on the first East African expedition, those of Speke and Grant on the second, and of Baker on his great journey to the Albert Nyanza, has prepared a memoir in which he endeavours to prove that these various altitudes are not inconsistent with Tanganyika being the furthermost lake of the Nile system, with an exit into Albert Nyanza. This important argumentative memoir will be read to us at our first meeting after the anniversary.

For myself, I give no opinion on a question which, like many others respecting African geography, can really be decided by positive survey only. Let us, then, trust that Livingstone has been enabled to solve this singularly interesting problem.

In the mean time, not believing in the death of Livingstone on the sole testimony of one of his cowardly baggage-bearers who fled, and who has already given different versions of the catastrophe, I am sure the Society and the public will approve of the course I recommended, and in which I was cordially supported by the council, and, to their great credit, by her Majesty's Government, namely, to send out a boat expedition to the head of Lake Nyassa, and thus ascertain the truth. If by this exhaustive search we ascertain that, sceptical as we are, the noble fellow did fall at that spot where the Johanna man said he was killed, why then, alas! at our next anniversary, it will be the sad duty of your president, in mourning for his loss, to dwell upon the wondrous achievements of his life. If, on the contrary, we should learn from our own envoys, and not merely from Arab traders, that he has passed on into the interior (and this we shall ascertain in six or seven months), why then, trusting to the skill and indomitable pluck of Livingstone, we may feel assured that, among friendly Negro tribes, who know that he is their steadfast friend, he may still realise one of the grandest geographical triumphs of our era, the connection of the great Tanganyika with the waters of the Nile system.

But even here I would have my countrymen who are accustomed to obtain rapid intelligence of distant travellers not to despair if they should be a year more without hearing any news of our undaunted friend. For, if he be alive, they must recollect that he has with him a small band only of faithful negroes, no one of whom could be spared to traverse the wide regions between Lake Tanganyika and the coast. Until he himself reappears—and how long was he unheard of in his first great traverse of Southern Africa!—we have, therefore, little chance of knowing the true result of his mission. But if, as I fervently pray, he should return to us, with what open arms will the country receive him, and how rejoiced will your president be, if he lives, to preside over as grand a Livingstone festival as he did when this noble and lion-hearted traveller was about to depart on his second great expedition.

The party which I have announced as about to proceed to Eastern Africa, to procure accurate information concerning Livingstone, will be commanded by Mr. E. D. Young, who did excellent service in the former Zambesi expedition, in the management of the *Lady Nyassa* river-boat. With him will be associated Mr. Henry Faulkner, a young volunteer of great promise, and two acclimatised men, one a mechanic and the other a seaman. The expedition, I am happy to say, is warmly supported by her Majesty's Government, and the building of the boat is rapidly progressing under the orders of the Board of Admiralty. The boat will be a sailing one, made of steel, and built in pieces, no one of which will weigh more than 50lbs., so that the portage of the whole by natives past the cataracts of the Shiré will be much facilitated. The Government have arranged for the transport of the party to the Cape, with the boat and stores, by the African mail-steamer, on the 9th of next month.* Arrived there, one of our cruisers will take them to the Luabo mouth of the Zambesi, where the boat will be put together, and the party—having engaged a crew of negroes—will be left to pursue their noble and adventurous errand, by the Zambesi and the Shiré, to the head of the Lake Nyassa. On account of the heavy seas which prevail on the western or leeward side of that lake, the expedition will keep close to its eastward shore, hitherto unexplored, and it is expected it will reach Kampunda, at the northern extremity, by the end of October, and there ascertain whether our great traveller has perished, as reported, or has passed forward in safety through Cazembe to the Lake Tanganyika.

Senegal.—In former addresses I have had occasion to record the great services rendered to geography by the enlightened Governor of the French possessions on the Senegal, Colonel Faidherbe, who has greatly extended our knowledge of the country along the banks of that river. The most advanced post of the French is Medine, near the cataracts of Felou, 600 miles from the mouth, up to which point the river is navigable, during the rainy months, for vessels drawing 12ft. of water. With a view to ascertaining the political condition of the countries beyond the eastern frontier, as also to fix accurately the geographical positions of places between the Upper Senegal and the Niger, an expedition was sent out by Colonel Faidherbe, in 1863, to traverse the distance between Medine and the important town of Segou, which had been visited by our own renowned traveller Mungo Park, sixty years previously. The mission was most ably and successfully carried out by Lieutenant E. Mage and Dr. Quintin of the French navy. Countries recently desolated by semi-religious wars carried on by Mussulman chiefs were traversed with great danger, and the positions of the route carefully laid down; the road taken being a *détour* to the north, after crossing the Senegal, by Diangounté, to Yamina, on the Niger, and thence by canoe to Segou. By this journey Lieutenant Mage has filled up a void in all maps of the region of the Upper Senegal, and corrected the positions of many places as previously laid down by Mungo Park and others; but the accuracy of our English traveller in the most important points is cheerfully acknowledged by his accomplished French successor, especially, for instance, in the position of Yamina, which Mungo Park fixed at 13° 15′, and Lieutenant Mage found to be 13° 17′ N. lat. The expedition returned to the mouth of the Senegal in June, 1866, and the French Geographical Society in the present year has rewarded the courageous leader with one of its gold medals.

* To the credit of the Union Steam Packet Company the boat has been taken out free of charge. Whilst these pages are passing through the press, I learn that the party sailed from Plymouth on the 11th inst.—JUNE 12, 1867.

ASIA.

Whilst, with the exception of the probable settlement of the north end of Lake Nyassa by the last journey of Livingstone, little has been added in the past year to our stock of knowledge respecting Africa, much information has in the same period been elicited regarding the geography of Central Asia, particularly as respects the physical features of those vast northern portions of it which have been explored by the Russians, and the positions of places and mountain ranges laid down by our own surveyors to the north of British India.

At the head of the labours which have elucidated the comparative geography of this quarter of the globe, I place the two remarkable volumes produced by our distinguished associate Colonel Henry Yule, C.B., entitled "Cathay and the Way Thither," published by our active auxiliaries the members of the Hakluyt Society, and of whose productions our Secretary, Mr. Clements Markham, is the perspicuous editor. Although the student of the former condition of China and the surrounding regions has ever dwelt with profit and delight on the descriptions of the great traveller Marco Polo, as first brought under the notice of modern English readers by Marsden, and as since rendered so popular by the excellent work of M. Pauthier, it was left for Colonel Yule vastly to extend our acquaintance with the amount of information possessed by our ancestors in the mediæval centuries which succeeded to the epoch when the great Venetian lived. By gathering together in one collection various records of other travellers in the East, commencing with those of the quaint and original Friar Odoric, of Pordenone, in the fourteenth century, Colonel Yule has not only satisfied the cravings of scholars, but has at the same time gratified geographers by the preparation of a most instructive map of Asia, such as it was when explored by those earlier travellers, and when it was ruled over by the different branches of the family of Chinghiz Khan.

The contrast between the statistical and political condition of Asia, particularly its central portion, in those days when mercantile men traversed it freely from Azof or from Tabriz to India and China, and the present time, when there exists so small an amount of land intercourse with Europe, is truly astonishing. In those days, and even as late as the sixteenth century, Samarkand, a city renowned as a seat of Mahommedan learning, was frequented by embassies, including one from the King of Spain. Even our own Queen Elizabeth was so anxious in the first year of her reign to open out an intercourse by way of the Caspian with Persia and India, that she addressed a letter to "the Great Sophi, Emperor of the Medes and Parthians." It was then (1558) that Jenkinson, our English traveller, made the journey from Astrachan to Bokhara, passing by Urghendj.

Now, with the exception of Russia, whose mission in 1841 has been noticed in previous addresses, no European power has had any source of intercourse with the truculent Emir of Bokhara, to whom much of this fine region is, alas! subjected. It has since been left to stray travellers, one of the last of whom is the enterprising Hungarian Vámbéry, to explain to the civilised world the real state of this region, once so important, and now so fallen through tyranny and misgovernment. No one can have read that author's sketch of the condition of the natives in either of the Khannats of Khiva or Bokhara without rejoicing that Russia has, through the energy of her Government, at last brought these barbarians to respect the frontiers of an empire which has established a safe line of communication between its own territories and those of China.

One ot the most important statistical results of modern geographical research, and the employment of natural means to a great end, is the bringing into real use, for the first time in history, the River Jaxartes of the ancients (now called the Syr Daria), and navigating it with steamers from its month on the Sea of Aral for many hundred miles into Turkistan and Kokand. By this great feat, and by the erection of forts, Russia has established an entirely new and well-protected route between Europe and China, far to the north of that followed by travellers and merchants in the middle ages, which was from the south end of the Caspian.

England, holding as she does so high a maritime position among the nations, may reflect with satisfaction on her great eastern traffic with India and China, carried on by her own great road, the ocean; and, far from envying the recent opening out of this land and river route through Central Asia, she may be well pleased that her northern allies should have a beneficial commercial traffic by caravans with those fertile regions of north-western China, with which, in fact, we never have had any intercourse, but with whom the Russians have traded for ages, though always until now with more or less impediment, due to the forays of the intermediate wild people, and particularly the Kokandians. The two great empires of Russia and China seem, in fact, to be destined by nature to interchange commodities by land and river communications through Central Asia; and so long as the line of such commerce between them is separated, as it now is, from British India and its dependencies by mountainous, sterile, and snowy regions, impassable by modern armies, there never can be the smallest ground of jealousy on the part of Britain.

On this head I was much gratified, at our very last meeting, in listening to the able memoir of Captain Sherard Osborn on the actual state of Chinese

Tartary, an enormous region that has become, through the relaxation of the Chinese hold, "no man's land," and in hearing from the eloquent author, as well as from the commentators on his memoir, that, instead of any apprehension being entertained regarding the late Russian advances, it was generally felt that it would be greatly to the advantage of the natives, as well as to British power in India, that the influence of a civilised Christian nation should be extended eastward over a region now becoming desolate through misgovernment and lawlessness.*

These considerations lead me naturally to say a few words upon the geographical operations of our medallist Admiral Boutakoff, which have mainly led to the establishment of the new Russian line of eastern traffic, and which have justly obtained for him a high reputation. The first of these enterprises might almost be called the geographical discovery of the Aral Sea. For, although this great mass of salt water had been known to Arabian geographers during several centuries under the name of the Sea of Khwaresm, though its shores had been visited by travellers, one of whom was the accomplished Russian geographer George von Meyendorf, who described the mouths of the Syr Daria or Jaxartes, at its north-eastern extremity, and another, General Berg,† who led a Russian expedition along its western banks in the winter of 1825-6, no ship had ever sailed upon this inland sea. The first vessel launched upon it was constructed at Oreuburg in 1848, and transported in pieces across the desert, and in it Boutakoff, after two years of navigation, defined the real shape of the coast, established the depths of the sea, and was the discoverer of the large island in it, the wild antelopes of which came to stare with astonishment, yet without fear, at their first invaders.

Fifteen years have elapsed since I communicated the first important paper of Bontakoff to this society, and it was spoken of with all the praise it merited in my Anniversary Address of the year 1853.‡ The successful exploration of the Jaxartes, and the discovery of its fitness for steam navigation, which was the next exploit of Boutakoff, led to the establishment of the great central route to China already mentioned, and Russia naturally availed herself of the commercial advantages thus presented in these natural features near the boundaries of her Asiatic possessions.

The question now arises, whether, by these enterprises, the honour does not truly belong to Russia of having, for the first time in history, defined the course of the Syr Daria and its exit into the Sea of Aral? The classical writers were, as I shall presently show, ignorant of the true geography of this region, particularly of its northern part, and an attentive consideration of its geological structure and physical outlines has led me, followed by the inquiries I have made among comparative geographers who have well studied the subject, to believe that their silence with respect to the Aral Sea is no proof that it has not existed during the whole of the historical era.

Holding this opinion, I necessarily differ from my friend Sir H. Rawlinson, who, in observations recently delivered from the chair of this society,§ made a very ingenious statement, and gave it as his opinion that there was sufficient evidence to show that in early times, say from 600 years before the Christian era to 500 or 600 years after it, both the river Oxus and Jaxartes flowed into the Caspian, the Aral being non-existent. That afterwards, and up to the year 1300, they fell into the Aral, and that for the next two hundred years (1300 to 1500) they came back into the Caspian, subsequently flowing gradually back into the Aral and forming the sea as we now know it.

Although I know that my colleague will admit that my geological data must have some weight, I have to claim his indulgence for venturing to question the views of so eminent a scholar respecting the changes of physical features in this region that may have happened in the days of history. Supported, however, as I am by the opinions of men on whose knowledge I place great reliance, I must say that I cannot regard the Persian manuscript, which was presented to Sir Henry by a clever chief of Herat, to be a document of sufficient value to override the conclusions at which I have arrived on many independent grounds.

Concerning the ancient course of the Oxus, I see no reason to differ from the Persian writer and Sir Henry. But when it is stated in the year A.D. 1417 the Jaxartes had deviated from its former course, and instead of flowing into the Caspian (as the ancients had it), joined the Oxus, and thus, the two rivers occupying one and the same bed, came into that sea, I must withhold my assent. This is a novel and striking statement, and before we attach credence to it we must have some physical evidence to sustain it. In my state of scepticism regarding the value of this Persian manuscript, now for the first time produced, that which strikes me *à priori* as a sign of its invalidity, is, that when this region was open to knowledge through the long-enduring reign of the civilised and literary Arabians (say from the seventh to the thirteenth century), the Aral was known and laid down as a distinct water-basin under the name of Sea of Khwarezm. On the other hand, when after that period knowledge became dim and local, and civilisation was at its lowest ebb, then it was that the Aral disappeared. My conclusion from this coincidence of the supposed emptying of the Aral, with the absence of records respecting it, would be that the sea had existed during all that time, but that there were then no geographers to record the fact.

In treating this subject, let us first consider the separation of the Aral from the Caspian as originally dependent on geological changes of the surface and then proceed to estimate the value we are to attach to the writings of the classical authorities in reference to a region so very imperfectly known to them. As a geologist who has studied this Aralo-Caspian question *in situ*, I beg to place on record in our geographical volumes my view of the pre-historic physical outlines of a region which, with the exception of the obliteration of one mouth of the Oxus, has, I venture to think, undergone no essential change during the human period.

According to all good authorities, including Humboldt, there existed in the latest tertiary, or what some call quaternary times, a vast depression on the surface of the globe, extending over 8,000 square marine leagues, in which a great inland sea was accumulated, and which, in a work on Russia, my associates and myself first mapped out under Humboldt's name of Aralo-Caspian.* In that sea there lived an abundance of molluscous and other animals, all of a species having a local and limited range, and all strikingly distinguished from the more numerous animals of oceanic seas. Now, owing to the upheaval of large portions of the bottom of that old inland sea, its animal contents formed, in a fossil state, the Steppe limestone, as seen at different levels over an enormous area. Owing to these pre-historic movements of the crust of the earth, these fossil remains are seen to occupy the strata on the banks of the lake of Aral, as well as on the shores of the Caspian Sea. They also occur at various places and at different heights in the adjacent Steppes, extending westward to the country of the Don Cossacks to the north of the Sea of Azof, where I have myself examined them. There is, therefore, no doubt that, in prehistoric times, the Aral and the Caspian, and also portions of a much wider region, now raised above them, were occupied by one vast internal and depressed sea, large portions of which have been desiccated. By these movements of elevation that part of the former great sea which became the Aral was elevated to about 117ft. above the former western part, or present Caspian, and the seas thus insulated were separated through the same movements by the elevated plateau now called Ust-Urt.

This was the physical condition of the region long before tradition or history. Humboldt has well remarked that the great Aralo-Caspian depression had a similar origin to the much deeper cavity in the earth's surface occupied by the Dead Sea, though the one is only 83ft., and the other nearly 1,300ft. beneath the ocean. Now, if we endeavour to account theoretically for the low present level of the old Aralo-Caspian Sea by evaporation only, we are met by the facts that large portions of its former bottom have been raised to different altitudes in the surrounding region, and that the levels of the Sea of Aral and the Caspian are also different, and are separated by the great plateau of Ust-Urt. As it is impossible to explain the existence of the much deeper cavity of the Dead Sea except by a greater sinking of the earth's crust, so is such a phenomenon precisely what geologists would expect to see realised as a natural and compensating result of the corresponding upheaval of the adjacent lofty mountains of Asia.

This being the conclusion at which geologists have arrived, let us see if it be interfered with by any reliable historical records. As to the knowledge possessed by Alexander, or his cotemporaries, it really does not touch the question of the relative courses of the Oxus and Jaxartes towards their mouths. For Alexander crossed the Oxus at about 400 miles above its mouth, and the most western point at which the great conqueror reached the Jaxartes was Cyropolis, where he passed it to defeat the Scythians; and that spot is about equidistant from the Aral Sea. Consequently, neither Alexander nor his generals could know anything of the real course of either river for great distances above their mouths. Scholars and comparative geographers doubt, indeed, if any weight can be attached to the unanimous statement of the Greeks, that both the Oxus and Jaxartes flowed into the Caspian, by mouths some 300 miles apart,† when they see how equally unanimous were the writers who came between Herodotus and Ptolemy in believing the Caspian to be but a gulf of the Northern Ocean! Again, we see how persistently the followers of Alexander confounded the Jaxartes itself with the Tanais, and fancied that they had doubled back upon the rear of Europe.

"The expedition of Alexander," says Humboldt, "far from extending or rectifying the geography of the Caspian Sea, confounded the Tanais with the Jaxartes, and the Caucasus with the Paropamisus or Hindu Kush."‡ Again, "It is through a singular combination of circumstances that the great Macedonian expedition, which in other respects extended the geographical horizon of the Western nations, became fatal to the geography of the Caspian Sea."§ Further on he says, "Some traces of the Sea of Aral, described as a great basin to the east of the Ural or Jaik River, are indeed found in Menander, the Byzantine historiographer; but it is only with the series of Arabian geographers, at the head of whom, in the tenth century, we must place El-Istachry, that we first obtain a certain knowledge of the topography of these countries."||

The truth is, that, when it was thus loosely said that both the Oxus and Jaxartes flowed into the Caspian, we must make due allowance for the ignorance of the ancients of the northern portion of this vast region, particularly of the course of the Jaxartes, which no one of them had fully explored, and at the mouth of which none of them had arrived.

If, indeed, we rely on the sagacious Rennell, he, in his great work on the "Geographical System of Herodotus," may be said to have established this point, for, in speaking of the old geographers, he says, "they understood the *Aral to be included in the Caspian*, since they knew but of one expanse of water in that quarter; for the Cyrus and Araxes, Oxus and Jaxartes, were all supposed to fall

* The reader who wishes to become acquainted with the physical features and boundaries of the districts of Chinese Tartary, so well expounded by Capt. Sherard Osborn, and of which he prepared a large map, must consult Keith Johnston's Library Map of Asia, published by Mr. Stanford, in the preparation of which Mr. Trelawney Saunders took a leading part.

† See the first published notice of the remarkable expedition of General Berg in 1825, in the work of myself and coadjutors, "Russia and the Ural Mountains," vol. i. p. 310. General Berg is now Count de Berg, and the Emperor's representative in Russian Poland.

‡ "Journal Royal Geographical Society." vol. xxiii., President's Address. p. 86.

§ See "Proceedings," Royal Geographical Society, 11th March, 1867.

* See "Russia in Europe and the Ural Mountains," vol. i., pp. 303-314, and particularly observe the map and section, p. 311, from the Sea of Azof across the Caspian and the Ust-Urt to the Sea of Aral.

† 2,400 stadia, according to Eratosthenes, and 80 parasangs, according to Patroclus both quoted by Strabo.

‡ "Asie Centrale," vol ii. p. 14.

§ Ibid. p. 153.

|| Ibid., p. 156.

nto the same sea." This he contrasts with the accurate subsequent knowledge of the Arabian geographers. And truly so, for this was the regular progress of observation, and a great advance over the ignorance of the classical writers respecting these hyperborean tracts. In those times the regions inhabited by the Massagetæ and the King of Kharasmia (the present Khiva) were barbarous countries, never explored by geographers; and, consequently, the classical authorities could only have obtained the little knowledge they possessed from native hearsay.

In his able essay on the "Life of Alexander the Great," Williams distinctly lays down, in his map of that period, the seas of the Aral and Caspian as distinct bodies of water. The same separation is given by Rennell, in his map of the twenty satrapies of Darius Hystaspes; and, whilst in it he indicates the Oxus flowing into the Caspian, and the Jaxartes into the Aral, he shows completely how the two seas were separated by what he terms the high plateau of Samob, the Ust-Urt of the present day.

Again, Thirlwall, in his "History of Greece," plainly leads us to believe that the Greeks could have known nothing of the Sea of Aral and the mouth of the Jaxartes, except what they derived from the reports of the King of Kharasmia, who came from a distance in the north to visit Alexander. In short, there is no historical evidence whatever to oppose the view, that the outline and structure of the Aralo-Caspiou region, as now seen, was determined, as I have said, long anterior to the historical era.

On the point of the prehistoric separation of the Aral from the Caspian, I entirely concur with Humboldt. "If we ascend,' he says, "to the primitive condition of the vast Mediterranean concavity, I should be led to believe that, notwithstanding the diminution of surface with the Caspian and Aral basins may have undergone in the historical times, from Hecatæus and Herodotus down to the tenth century of our era—*i. e.* to the days of the Arab geographers El-Istachry and Ebn Haukal—the event of the separation of the Aral and Caspian remounts to a geological epoch, which, like the separation of the Euxine and the Caspian, or the opening out of the Dardanelles and the Straits of Gibraltar, are all ante-historical, or far beyond any human tradition."*

In sustaining this view it is to be remarked that, whilst the Aral Sea trends from north to south, the Syr Daria and its embranchment the Kuvan Daria, which flow into it from the east, have had courses at right angles to that sea itself; thus favouring the geological view that the great movement which produced the plateau of the Ust-Urt, separated the Sea of Aral from the Caspian, and left the chasm occupied by the Aral, was also accompanied (as is usual in such elevations) by transverse flanking openings in the mainland, on the east, along which those rivers flowed. In this view the parallelism of the Syr Daria to that of the Kuvan Daria, about fifty miles south of it, is remarkable.

If the Jaxartes ever flowed to the south-west, as suggested by Sir H. Rawlinson, it must have joined the Oxus long before the united streams fell into the Caspian, which is very distant from the nearest point of the valley of the Oxus. But if such an union of the great streams ever existed in so southern a latitude, it must have been perfectly well known to the ancients, and they have made no allusion to it. On the contrary, they believed and have stated, that the rivers fell independently into the Caspian, and by different courses, separated from each other by a wide interval.

Whilst I think that, probably, the many-mouthed Oxus always sent a large portion of its waters into the Aral, I also quite believe that one of the branches debouched formerly into the Caspian, as explained by Humboldt, and as proved, indeed, by the old English traveller Jenkinson, to whom he refers. It will also be presently seen that the distinguished Asiatic geographer Semenof would explain the desiccation of the former or Caspian branch of the Oxus in another manner. The stoppage of that watercourse (formerly an unusual line of traffic) may also be accounted for by a local elevation of land in that latitude; for it is not remote from the scene of igneous eruptions that produced volcanic mountains, as the greater and lesser Balkan, near the ancient desiccated mouth of the Oxus. Such a change of level may, indeed, have been caused by the same subterranean forces which, in this latitude, evolve, at the present day, the fires of Baku, and have recently thrown up volcanic mud-islands near the southern end of the Caspian. The elevating effect of these forces would deflect the Caspian branch of the Oxus and cause its waters to unite with the branches which flowed northwards into the Aral Sea.

(To be continued.)

THE ELECTRIC LIGHT.

An interesting exhibition of the electric light, with a view to lighthouse purposes, took place recently on the high ground near Granton. At this spot some temporary buildings have been erected by the Commissioners of Northern Lights to carry on these experiments. As yet the arrangements are not completed, and the light was on the above occasion exhibited from a temporary stage, visible in the proper focus from the eastern breakwater at Granton. The Lord Provost and another Commissioner were in attendance, with several gentlemen who felt interested in the proceedings. The night, unfortunately, was dull and showery, but this did not prevent the experiments being carried out. The apparatus consists of a group of permanent and electro-magnets, within which revolve armatures, moved at a great velocity by power from a steam-engine. Currents of electro-magnetism being disengaged flow through two copper wires to the stage outside, where we find the mechanism arranged for producing the electric spark in a stream of continuous brilliancy. The difficulty all along has been to secure continuity, and this has at length been happily overcome. Two stalks or rods of carbon—not unlike two thick stalks of slate-pen—are vertically placed one over the other, with a small interval between the two approaching points. It is betwixt these two points that the light appears; the resistance of the two currents producing the required light. In giving off the streams of magnetism, the carbon is slowly consumed, and thereby a process of keeping the rods in proper approximation is of paramount importance. The concentration of the light, or its radiation, may be adjusted by lenses or reflectors, as in the ordinary lighthouse system. The adoption of this kind of electro-magnetic light to lighthouses has been carried to a practical issue by Professor Holmes, an apparatus of this kind being in use, we believe, at Dungeness. There is also a French electric light at Cape la Heve, near the port of Havre. As yet, however, the whole process, as far as economic purposes are concerned, may be said to be experimental, or at least not fully established. The apparatus erected by the Commissioners of Northern Lights is that of Mr. H. Wilde, a noted experimentalist in this branch of science. Unquestionably, the light exhibited under the disadvantages of inclement weather, on an open, unprotected stage, was of surprising brilliancy—white—and so intense, as to be scarcely endurable to the naked eye within a short distance. All present were impressed with the beauty and power of this extraordinary artificial light, approaching so nearly as it did to the light of the sun. After seeing it from the eastern breakwater at the distance of about a mile, the Lord Provost proceeded to the lighting premises, in order to see what effect could be produced by using a reflector to light lines of streets. Mr. Wilde having adjusted the apparatus accordingly, a broad stream of light resembling the clearest moonlight was sent down the road towards Granton, affording conclusive evidence that, as regards the lighting of towns, the electric light may at no distant day be brought into practical operation, so as to supersede the rows of gas lamps at present in use.

* Humboldt, "Asie Centrale," vol. ii., p. 146.

THE GRIEVANCES OF MINERS.

The select committee on mining, which during the last session of Parliament sat so many days and took evidence enough to fill a blue book of 800 pages, has at length brought its labours to a termination. Mr. Neate, the chairman, laid the report on the table of the House on July 31st. The document, which is a lengthy one, has not yet been printed, but the following are its principal features. The committee are of opinion that the employment of women on the pit banks does not require legislative prohibition or further interference. They recommend that no boys should be employed in any mine under the age of twelve; that a register of boys under the age of fourteen be kept in a form to be prescribed by the Secretary of State; that no boy under the age of sixteen be under ground in any mine for more than twelve hours out of the twenty-four; that children and young persons employed above ground shall be subject to such regulations as to education and labour as shall be laid down by any general act for the regulation of such matters, regard being had to the customs and exigencies of operations incident to the working and management of mines and collieries. They find that the intention of the law as against payment of wages by "truck" is frequently defeated, more especially in Scotland, and that the law required some alteration in order to render it more effectual. They recommend sundry alterations and additions to the "general rules" laid down by the Act of Parliament for the working of mines; that in all coal workings where safety lamps are required by the special rules of the mine no gunpowder shall be used for blasting the coal; that in all places where an accumulation of water is likely, the place must be approached by a "wording" not exceeeding twelve feet in width, with the bore-hole constantly in advance, and with plank bore-holes; that in approaching places where there is likely to be accumulation of gas the use of safety lamps shall be imperative. They also decide that it is expedient to prohibit in all cases the deduction of the price of the timber used in propping from the wages of the miner; that it is expedient to provide that it shall not be lawful to employ more than 100 persons in any mine unless such mine be divided into separate district or panels, in such a manner that each separate district or panel shall have one or more independent "intake," and return airways from the main airways to the main return or upcast. With regard to inspection (a much controverted point) they say that the present staff of inspectors should be increased, with a view to more frequent inspection; but it is not desirable that men of a lower standard than those at present selected should be employed in the discharge of this important duty. The committee also consider the present method of selecting arbitrators unsatisfactory, and that, instead, the inspector and mine owner should appoint their own arbitrator, and that the two arbitrators should appoint an umpire. They think it desirable to appoint stipendiary magistrates for the more populous mining districts.

REVIEWS AND NOTICES OF NEW BOOKS.

Readwin's Index to Mineralogy. London: E. and F. N. Spon.

Mr. Readwin has done great service to the scientific world by collecting from all available sources the materials for making a much more correct list of minerals than has hitherto existed. The index is arranged in an alphabetical list, containing the names of about 2,500 minerals, with concise references to their composition, synonymes, and place in the British Museum. Although the compiler in his preface states that the list is obviously imperfect, and little more than an index to a more extended work on the subject, he has not the less deserved the thanks of mineralogical students for drawing their attention to the subject, and which may ultimately be the means of producing a list of minerals really deserving the name.

Irrigation in Spain. By J. P. ROBERTS. C.E. London: R. and F. N. Spon. 1867.

This pamphlet contains a number of interesting facts and figures concerning the works of irrigation existing in Spain and those in course of execution.

As the subject of irrigating land and the construction of new works occupies the public attention at the present time, Mr. Robert's pamphlet has been very opportunely published, and the information given has been collected with great care.

A Treatise on the Screw Propeller. By JOHN BOURNE, C.E. London: Longmans, Green, Reader, and Dyer. Parts xxii and xxiii.

As the publication of the present edition draws to a close, the monthly parts become volumes in themselves. The July part consists of 48 pages of letter-press, accompanied by two sheets of well-executed illustrations; whilst the part for August contains 60 pages of letter-press and four plates, each illustrating marine engines, having some interesting features.

The Engineer Officers Navy List, for August, 1867. Devonport: J. R. H. Spry.

The second issue of this useful handbook of information for the steam branch of the Royal Navy, is a considerable improvement upon the one that preceded it. The names of the officers serving on board are given in the list of ships and vessels, as well as separately in the classified lists. Such a handbook has been long felt as a want, and we wish the publisher success in the undertaking, and it rests with the engineers themselves to make the next succeeding publication still more complete.

A New Chemical Nomenclature. By S. D. TILLMAN, A.M. Albany, U.S.: C. Van Benthuysen and Sons.

Professor Tillman, who is well known as the Professor of Technology in the American Institute, of the City of New York, has issued in pamphlet form, the first of a series of papers treating of a new chemical nomenclature, by which, as he says, students who formerly found themselves in a quagmire of incongruous names, may now "advance on firm ground and view with satisfaction and profit the fair fields opened on either side by the distinguished chemists of our own time."

The papers, of which the present pamphlet contains the substance of several, were read at the meetings of the American Institute for the Advancement of Science, and are based on the almost self-evident necessity for a thorough overhauling of the existing nomenclature employed more particularly by English chemists, and the author falls foul of the attempts to define acids, for instance, containing more or less oxygen by adapting as terminals, *ic* and *ous*, and the corresponding terminals *ate* and *ite* for salts, and various other defects in the existing system of chemical nomenclature. Professor Tillman's pamphlet is certainly worthy of the attention of chemical students, and we trust he will follow out the work still further and publish a complete work on the subject. Unfortunately we are not able to inform our English readers where the work can be obtained in England.

HARBOURS OF REFUGE.—The annual reports of the engineers show that at Portland the quantity of rough stone deposited in the breakwater mound, and the foundations of the heads, has reached 5,627,654 tons. With the exception of some temporary damage to masonry in the gales of January and March, the works have stood successfully the storms of the winter, and large numbers of vessels have taken shelter within the harbour. At Dover, the expenditure upon the breakwater, or west arm of the harbour, has reached £611,277, the estimate being £725,000. At Alderney, the expenditure at the end of March—the period at which all these reports are made up—had reached £1,140,513, the estimate being £1,060,000. At Holyhead, at that date, a length of 7,037 feet of the superstructure of the north breakwater had been built to its full height, and a length of 7,124 feet was built about high water; the inner, or harbour wall, was built to its full length of 5,930 feet. In the year ending the 31st of March, 3,647 vessels sought the shelter of this harbour. The expenditure had reached £1,371,155.

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Foreign on the spot, per ton	20	17	6	21	0	0
Do. to arrive	20	17	0	21	0	0
ZINC.						
In sheets, per ton	27	0	0	,,	,,	,,
TIN.						
English blocks, per ton	91	0	0	,,	,,	,,
Do. bars (in barrels) do.	92	0	0	,,	,,	,,
Do. refined do.	94	0	0	,,	,,	,,
Banca do.	92	0	0	,,	,,	,,
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IC. charcoal, 1st quality, per box	1	7	6	1	9	6
IX. do. 1st quality do.	1	13	6	1	15	6
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IX. do. 2nd quality do.	1	11	6	1	13	6
IC. Coke do.	1	3	6	1	4	6
IX. do. do	1	9	6	1	10	6
Canada plates, per ton	13	10	0	,,	,,	,,
Do. at works do.	12	10	0	,,	,,	,,
IRON.						
Bars, Welsh, in London, per ton	6	10	0	,,	,,	,,
Do. to arrive do.	6	10	0	,,	,,	,,
Nail rods do.	7	0	0	7	10	0
Stafford in London do.	7	10	0	8	10	0
Bars do. do.	7	10	0	9	10	0
Hoops do. do.	8	10	0	9	12	6
Sheets, single, do.	9	5	0	10	0	0
Pig No. 1 in Wales do.	3	15	0	4	5	0
Refined metal do.	4	0	0	5	0	0
Bars, common, do.	5	15	0	6	0	0
Do. mrch. Tyne or Tees do.	6	10	0	,,	,,	,,
Do. railway, in Wales, do.	5	10	0	6	0	0
Do. Swedish in London do.	10	5	0	10	10	0
To arrive do.	10	5	0	,,	,,	,,
Pig No. 1 in Clyde do.	2	14	0	3	3	6
Do. f.o.b. Tyne or Tees do.	2	9	6	,,	,,	,,
Do. No. 3 and 4 f.o.b. do.	2	6	6	2	7	0
Railway chairs do.	5	10	0	5	15	0
Do. spikes do.	11	0	0	12	0	0
Indian charcoal pig in London do.	7	0	0	7	10	0
STEEL.						
Swedish in kegs (rolled), per ton	14	5	0	,,	,,	,,
Do. (hammered) do.	15	0	0	,,	,,	,,
Do. in faggots do.	16	0	0	,,	,,	,,
English spring do.	17	0	0	23	0	0
QUICKSILVER, per bottle	6	17	0	,,	,,	,,
LEAD.						
English pig, common, per ton	19	15	0	,,	,,	,,
Ditto. L.B. do.	20	0	0	,,	,,	,,
Do. W.B. do.	21	15	0	,,	,,	,,
Do., ordinary soft, do.†	20	0	0	,,	,,	,,
Do. sheet, do.	20	10	0	20	15	0
Do. red lead do.	20	15	0	21	5	0
Do. white do.	27	0	0	30	0	0
Do. patent shot do.	23	0	0	,,	,,	,,
Spanish do.	19	5	0	19	10	0

* At the works 1s. to 1s. 6d. per box less.

† A Derbyshire quotation, not generally known in the London market.

NOTES AND NOVELTIES.

MISCELLANEOUS.

Patents.—The Lord Chancellor, the Master of the Rolls, and the late and the present Attorney-General (the latter then Solicitor-General), as commissioners of patents, report that 2,124 patents were passed in the year 1866. The amount received in the year for stamp duties, the fees being now paid by means of stamps, was £114,461, which was more than double the expenditure of the department, though this must have been upon a liberal scale if we may judge from the first item, £9,428, paid in fees to the Attorney-General and the Solicitor-General, and £856 to their clerks. The receipts included £31,400 for continuing old patents beyond the first three years of their term of 14 years, and £21,900 for continuing old patents beyond the first seven years of their term. The fee of £50 for continuing a patent beyond its third year is paid on about 30 per cent. of the patents issued, and the other 70 per cent. become void at the end of three years. The further sum of £100 payable at the end of the seventh year is paid on about 10 per cent. of the patents issued, so that 90 per cent. are allowed to become void at the end of the seventh year. The commissioners continue their work of publishing abstracts or abridgments of all specifications from the earliest enrolled to the present time; they are issued in classes and chronologically arranged, sold at the mere cost of printing and paper, and presented to the authorities of every important town in the kingdom on condition that they shall be accessible to the public daily, free of all charge. The new classes in course of preparation relate to fuel, steam engines, railways, railway signals, hydraulics, ventilation, rolling stock, raising, &c., heavy bodies, acids and alkalies, agriculture, optical, &c., instruments, roads, stone and cement, writing instruments and materials, saddlery, and bridges. After the present year all patentees will be required to deliver with the specification an abridgment of it, and these abridgments will be published in quarterly volumes after the expiration of the six months' protection. The commissioners reprint extracts from former reports on the need of a proper building for offices and public museum and library, and state that the present building is now filled, and there is a continual increase of specifications and scientific works, for which provision must be made. The large amount of surplus of fees received over expenditure provides a fund from which the cost of a proper building might be defrayed.

An enormous cannon has been recently added to the Paris Exhibition which, within the last few months, has been produced at the Imperial Foundry at Ruelle. It consists of a cast-iron body, strengthened by two steel coils; the weight of this piece is 37 tons; diameter of the chamber is rather less than 17in.; it is a smooth-bore breech-loader. The shot to be used for this gun weighs 600lbs., and is solid and spherical; the shell is also spherical, weighs 420lbs., and contains 18lbs. of powder; the charges required for the two are 100lbs. and 66lbs. respectively.

Twin-Screw Propulsion.—In the House of Commons, Mr. Corry, in reply to Lord Enfield, said that numerous memorials had been received from Mr. George Gill, of Hoislow, claiming the invention of the twin-screw plan of propulsion. His proposals had been reported on ten times since April 1864; but in the opinion of the late, as well as of the present, Board of Admiralty, Mr. Gill had no grounds for preferring any claim against the Government for compensation or reward.

It appears that the Table Rock on the Canadian side of the Niagara Falls is in a very dangerous condition and efforts are now being made to remove it by blasting. Ten blasts were recently made in the rock, each one containing one and a half pound of powder. This had but little effect on the rock, merely causing a slight explosion on the surface. It is said another attempt will be made with fifty pounds of powder, and it is thought that it will succumb to this. The greater part of the Table Rock is separated from the main land by a space of several inches in width and several feet deep, presenting a very dangerous appearance.

The Coal Supply to London.—It would appear that the sea-borne coal for the metropolis is fast being superseded by that carried by railway. For the half-year ended June in the present year, the entire quantity carried over sea to London was 1,454,693 tons, against 1,488,973 tons for the corresponding period of 1866, showing a decrease of 32,480 tons tons, On the other hand, there was carried by railway during the first six months of the present year 1,567,533 tons, against 1,413,100 tons for the same period of 1866, being an increase of no less than 154,453 tons.

An official return has just been published of the produce of the gold districts of Russia during the year 1865, from which it appears that there has been a considerable increase in the supply over that of previous years. In 1864 the total amount of gold produced in the empire was 22,942 kilogrammes, and in 1865, 26,080 kilogrammes. In Eastern Siberia, 2,743 kilogrammes more were produced in 1865 than in 1864.

Defying a World of Thieves.—An iron safe shown at the Paris Exhibition by Mr. Silas Herring, of New York, bears a ticket with the words:—"*Defi au monde entier.*" The challenge has just been accepted by an English manufacturer of similar articles named Chatwood, who undertakes to pick the lock for a wager of 15,000f., which has been deposited by both sides in the hands of M. Le Play, Commissioner-General. A jury of five engineers—two English, two American, and one French (said to be M. Fichet)—has been named to preside. The winner engages to divide the stakes of 15,000 between the charitable institutions of Washington, London, and Paris.

French local papers give a curious account of the result of sinking an Artesian Well in the Department of Aude, near Narbonne. When the depth of 180 feet had been attained, a stream of carburetted hydrogen gas rushed up the tube, which, being lighted, has continued to burn steadily with a red flame. Along with this gas water flows, which is stated to be extremely bitter and cold.

The Thames Conservancy.—The conservators of the river Thames state, in their report for the year 1866, just issued, that in that year proceedings were instituted against persons for throwing mud into the river, and against the owners of gas and chemical works, for permitting gas refuse and offensive matter to pass into the river, and seventy-seven convictions were obtained. On the passing of the Thames Navigation Act of 1866, which imposed on the conservators the management of that part of the river which extends from Cricklade to Staines, they immediately took measures to effect such repairs as were urgently required to keep open the navigation, and preserve the course of the stream, and caused surveys of the river to be made, to enable them to determine on the works of a permanent character which would be needful. By the 52nd section the duty of scavenging the river was imposed upon the conservators, and this has been carefully attended to. Early in 1867, and as soon as the conservators had obtained the necessary information they caused notices to be served on the proper authorities at Oxford, Abingdon, Wallingford, Reading, Henley, Marlow, Cookham, Windsor, and Eton, requiring them to discontinue the flow or passage of sewage, or any other offensive or injurious matter into the river. On the 6th of December, 1866, the election of four additional conservators under the provision of the 7th and 8th sections of the Act of 1866, was held at Oxford, and the following gentlemen were elected:—Rev. J. G. Clutterbuck, of Long Wittenham; Colonel E. W. Harcourt, of Nuneham Park; Mr. J. K. Hedges, of Wallingford Castle; and Mr. C. H. Witherington, of Sonning. Pursuant to the 90th section of the Act of 1866, notices were given for an Act of Parliament to extend the provisions of the Act of 1866 to the river between Staines and the western limit of the metropolis, and a bill was prepared accordingly.

The Crinan Canal.—The navigation of the Crinan Canal suffered no interruption during the past year from a deficiency of water, as in the previous summer, and its traffic was generally satisfactory; but in January it was closed for three weeks by frost. The revenue has attained a point higher than that of any previous year. In the year ending the 30th of April, 1866, the receipts of the canal and harbour amounted to £3,375 14s. 7d.; in the year ending the 30th of April, 1867, they had risen to £4,324 18s. 2d., thus showing an increase of £949 3s. 7d. This increase has been mainly due to an alteration of the dues on steamers upon the canal, which the commissioners introduced last year, and to the running of a new line of steamers between Helensburgh and Ardrishaig, which has now been discontinued. The general traffic has also exceeded the average of former years. The revenue derived from passengers amounted to £513 7s. 3d. It is, however, necessary to state that the general account of receipts includes the payment of £200 contributed by local proprietors towards the new bridge and approaches at Ardrishaig. The expenditure of the year ending the 30th April, 1866, was £3,707 16s. 11d., and of the year ending the 30th of April, 1867, £3,829 18s. 9d., thus showing an increase of £122 1s. 10d., but this comparative increase is due to the cost of completing the bridge and approaches at Ardrishaig, one half of which was defrayed by local contributions. The account of expenditure embraces payments exceeding £700 on account of new works and improvements. The receipts of the past year exceeded the expenditure by £495 19s. 5d., and enabled the commissioners to reduce the balance against them at the Bank of Scotland from £778 1s. 9d. to £317 18s. 1d. They have continued the annual payment of £250 in diminution of the balance on the old account, which has now been reduced to £822 5s. 8d., and will be extinguished in three years. The prospects of this navigation are generally encouraging, but the harbour dues at Ardrishaig are threatened with serious loss by a recent alteration in the admeasurement of the tonnage of steamers. Under the new system the tonnage of steamers is estimated at from one-third to one-fourth less than formerly. For instance, the registered tonnage of the *Iona* has been reduced from 191 tons to 141 tons, and a corresponding diminution of the dues has followed. To protect themselves from the loss of revenue the commissioners have deemed it necessary to raise the harbour dues on steamers at Ardrishaig from ¾d. to 1d. per registered ton.

Caledonian Canal.—The sixty-second report of the Commissioners of the Caledonian Canal states that it has afforded unusual facilities during the past year to the commerce and traffic of the country, and its resources have been found equal to its requirements. The Commissioners noticed in their last report that extended accommodation had been afforded to passengers by the placing of another large and commodious steamer, the *Gondolier*, upon the line, and by the establishment of a fast passenger traffic daily in each direction between Banavie and Inverness, and this arrangement had been continued during the present season. During the winter months an unusual number of sailing vessels of heavy burden were passed through the canal in stormy weather without accident or detention. Several new works and improvements in the navigation have been executed during the year. Among them may be enumerated the deepening the navigable channel of Loch Dochfour, the completion of works for the renewal of the timber pier at Corpach, the providing of materials for raising the wing walls at some of the locks, and for other operations, and the building of additional lock-houses at Corpach, Aberchalder, and Clachnaharry. The steam tug-boats have been kept at work with comparative little repairs, but the time is approaching when it will be necessary either to renew them or otherwise to provide for the steam-tug service. The revenue of the canal has increased as compared with the previous year. In the year ending the 30th of April, 1866, the receipts amounted to £6,195 16s. 5d.; in the year ending the 30th of April, 1867, to £6,541 13s. 11d.; thus showing an increase of £345 17s. 6d. The expenditure, however, has been unavoidably increased in a somewhat greater proportion than the revenue, having amounted in the former year to £6,047 17s. 3d., and in the latter to £6,698 10s. 4d., thus showing an increase of £650 13s. 1d. The result of this increased expenditure has been an excess of payments over receipts within the year of £156 16s. 5d. In making this comparison of the two past years it must, however, be stated that in the first of them the expenditure was exceptionally low, and that in the latter the extraordinary expenses of important repairs and permanent improvements of the navigation amounted to little less than £1,000. The balance of the commissioners at the Bank of Scotland as at the 30th of April last was £1,221 10s. 6d. The general traffic of the canal exhibits a satisfactory improvement, the total number of passages of sailing and steam vessels having increased from 1,695 in the previous year to 2,004 in the last year; and the tonnage dues from £4,174 0s. 10s. to £4,920 8s. A considerable number of cargoes of linseed and flax were conveyed from the Baltic to the Irish ports, and although the herring fisheries on the east coast have not recovered their former prosperity, a new fishery has lately been established along the inner shores of the Island of Lewis, Harris, and North and South Uist, which being extensively carried on by fishing boats from the Moray Firth, has to some extent compensated for the loss of traffic occasioned by the continued depression of the eastern fisheries. The second swift steamer has also contributed to the tonnage dues levied within the year, in addition to the encouragement which it has naturally afforded to the passenger traffic. The proceeds of the transit toll on passengers amounted to £490 8s. 7d.

Hart's Improvements in the Application of Jukes's Smoke-consuming Furnaces.—The principle of Jukes's self-feeding furnace, by which the coals are caused gradually to travel from the coldest to the hottest part of the furnace, and by which means the gaseous products given off by the fuel near the door are consumed whilst passing over the more highly heated coals at the other end, has long been acknowledged as correct. Great numbers of land boilers have been fitted with furnaces on this principle with excellent results; but it was always considered that a large furnace was essential to success, to allow for the space occupied by the driving gear, and, consequently, only those boilers which were fired from the outside were adapted for such an alteration. Mr. David Hart, however, who has had great experience in manufacturing and fitting these furnaces, has at length succeeded in applying this system to Cornish and other internally fired steam boilers by making a few simple modifications in the traversing gear, by which means the entire width of the flue is made available for grate surface, while, at the same time, the plan he adopts for fixing the drawing gear, hopper, &c., entirely obviates the necessity of pulling down the brickwork setting of the boiler; and thus the only objection to the universal application of this important principle has been removed.

NAVAL ENGINEERING.

A Norwegian Monitor.—The Norwegians have just completed a monitor called the *Scorpion*, which is now on its way to Stockholm. It carries in a turret two Armstrong guns which throw 350lb. shot with a charge of 44lb. of powder. The guns weigh 74,000lbs. Notwithstanding this, the machinery for working them is so excellent that they can be manœuvred by one man alone. The sides of the iron turret are eleven inches thick, and are lined inside with horsehair mattresses. The monitor is worked by engines of 150 horse-power, and is manned by eighty men, twenty of whom attend to the engines and twenty man the gun. The cost of the monitor and her equipment has been £50,000.

STEAM SHIPPING.

The steamship *Omega* sailed from Woolwich Arsenal on Saturday, August 10th, for Malta, after shipping from the T pier 188 tons of wrought-iron plates, bolts, &c., and 28 tons of grindstones and light cargo. The plates are 5½in. and 5in. thick, and weigh from 4 tons to 5½ tons each. They are intended for the construction of shields to protect the

guns and gunners, as ordered to be adopted in the new casemated works now in course of erection at Malta, Gibraltar, and Bermuda. The whole have been supplied under contract by Messrs. Cammel, of Sheffield, and have been most favourably reported on by the Board of Works at Woolwich. One of the shields has been erected in the Royal Arsenal marsh, and is an object of considerable interest. The shield consists of a couple of 5½in. plates laid on horizontally, and backed by the same number of 5in. plates vertically. They are secured by heavy conical-headed bolts, and an inner skin of 1½in., having an embrasure in the centre, and supported by struts, on the system of Lieut.-Col. Taylor, Royal Engineers. It is calculated that, as at present constructed, they will afford ample resisting power to any battering iron known to our artillerists, not excepting the Palliser 600-pounder, fired at 500 yards. Should, however, the progress of science and experience render any additional strength necessary, that could be added to an indefinite amount while in position. The steamship *Galatea*, with a similar portion of cargo, for Gibraltar, from Woolwich Arsenal, took her departure from Gravesend on the 10th August, where she shipped 100 tons of ammunition, in addition to the above named.

SHIPBUILDING.

Ships Built.—A Parliamentary return just published shows that during the past year 631 vessels were built in England and Wales, 270 in Scotland, and 16 in Ireland. Of the sailing vessels built in England and Wales, 51 were of iron, 364 of wood, and 23 composite. Of those built in Scotland, 30 were of iron, 102 of wood, and 17 composite; and of those built in Ireland, 4 were of iron and 1 of wood. The steam vessels built in England and Wales consisted of 38 wooden and 155 iron ships; in Scotland, 2 of wood, 116 of iron, and 2 composite; and in Ireland, 11 of iron. By particularising the above total numbers, it is found that 17 vessels of all kinds were built at Dartmouth, 23 at Grimsby, 39 at Hull, 38 at Liverpool, 32 in London, 11 at Middlesborough, 44 at Newcastle, 22 at Rye, 38 at North Shields, and 149 at Sunderland. Of Scottish ports, 16 vessels were built at Aberdeen, 21 at Banff, 121 at Glasgow, 14 at Perth, and 24 at Port Glasgow. Liverpool furnishes the largest quota of iron sailing ships, and Glasgow the largest number of iron steamships. The largest number of wooden sailing vessels was built at Sunderland, and of wooden steam vessels at North Shields. This last class of ships is, however, decreasing annually, 40 only having been built in the United Kingdom during the past year, as compared with 283 iron steamships. Of the vessels above 50 tons built in the year 1866, 121 of 68, 134 tons were built at the port of Glasgow, 149 of 59,254 tons at Sunderland, 44 of 27,961 tons at Newcastle, 38 of 23,667 tons at Liverpool, 32 of 17,734 tons at London, 18 of 14,276 tons at Greenock, 38 of 13,548 tons at North Shields, and 19 of 5,087 tons at South Shields, 39 of 13,288 tons at Hull; 16 of 11,571 tons at Aberdeen, 24 of 10,689 tons at Port Glasgow, 9 of 6,655 tons at Stockton, 8 of 6,559 tons at West Hartlepool, 11 of 6,476 tons at Middleshorough, and 12 of 5,997 tons at Dundee.

Ship Launches on the Wear.—The following ship launches have recently taken place:—From the yard of Messrs. Robert Thompson and Sons, North Sands, the barque *John Byers*, 349 tons register, and of the following dimensions:—Length, 119ft.; breadth, 27ft. 6in.; depth, 17ft. 1in. She is classed 9 years at Lloyds, is sold to Mr. Matthew Robson, Monkwearmouth, and is intended for the Mediterranean trade. Also, from the yard of Mr. Benjamin Hodgson, Hylton, the brig *Rothbury*, 266 tons register, and of the following dimensions:—Length, 108ft.; breadth, 26ft.; depth, 15ft. 6in. This vessel is sold to Blyth owners, is classed 9 years at Lloyds, and is intended for the Mediterranean trade.

RAILWAYS.

There is reason to believe that Prussia is seriously contemplating the construction of a railway bridge across the Elbe, at a spot that has hitherto never entered into the wildest dreams of the most speculative engineer—namely, below Altona, near the terminus of the Kiel and Altona Railway. There can be no doubt that, as the two banks of the river belong to Prussia, that power has as much right to build a bridge there as over the Rhine at Cologne and Coblentz, where both banks are also Prussian; but should the plan be really executed, Hamburg will be cut off from all direct communication with the sea, and then good-bye to its commercial prosperity. From being fully as much a seaport as London at present, it will become as much an inland city as Dresden or Berlin. The trade of Altona will also be totally ruined by the bridge; but, as that town is now Prussian, the Government has the right to do what it likes with it. As far as regards Hamburg, however, the case is different; and, in an international point of view, it is very doubtful whether Prussia has the right to cut off the sea-going ship traffic of an independent state, and so preclude it from direct commercial intercourse with the rest of the world. It is true that, as yet, the intentions of the Prussian Government are not officially known, but all that has transpired on the subject has come through the semi-official organs—however, it is certain that a Government railway engineer has been sent down to "study" the locality for the proposed bridge, and the authorities at Altona have received official instructions from Berlin to render him every assistance and facility in their power.

New Route between Liverpool and London.—The increase of traffic on the London and North-Western Railway between Lancashire and the south induced the directors some years back to take steps to provide a new outlet for the traffic from Liverpool. Of the various routes surveyed one *viâ* Runcorn was finally selected, though it involved the construction of a most expensive and gigantic bridge across the treacherous shallows of the river Mersey at Runcorn-gap. The subject being finally decided upon, energetic steps were at once taken to push on the works. The foundation-stone of the bridge was laid in 1864, which is rapidly approaching completion. The total length of the structure, including the slopes on either side of the river (there being sixty-five arches on the Lancashire, and thirty-two on the Cheshire side of the river), is a mile and a half. The river will be traversed by means of a huge iron bridge, consisting of three "stretches" of wrought-iron girders, resting on two stone piers rising from the bed of the river, and two on the margins at either side. Each of these "stretches" measure 305ft., the height above the river at spring tides being 75ft. to the under edge of the girders, and 78ft. 6in. to the surface of the rails. The framework of the bridge proper consists of four iron beams, which extend the whole length of the span, the outer beams being strengthened on both sides by a trellis-work 40ft. in depth, which, while helping to bind the structures gives to the huge mass a comparatively light and airy appearance. Of the arches which form the remainder of the viaduct, 88 have each a span of 40ft. and nine of 61ft. 6in. The total cost of the viaduct and bridge will probably exceed £300,000.

TELEGRAPHIC ENGINEERING.

The Telegraph to India.—A second scheme for the purpose of improving telegraphic communication between England and the East is being promoted by an association which has its directors in London and Berlin. The new company propose to lay a cable between the English and Prussian coasts across the Channel, joining which, would be an overhead line passing through Prussia and Russia to the Black Sea, across which a new deep sea cable, 280 miles in length, will be laid between the Crimea and the Circassian coast, which will ultimately join the existing lines through Persia and along the Persian Gulf to Kurrachee and Bombay. With regard to the cost of construction the new scheme seems to possess an advantage over that projected by the promoters of the Anglo-Indian Company. The line through Prussia and Russia would consist almost exclusively of overhead lines, whereas the lines to be constructed by the Anglo-Indian Company will consist of deep sea cables. With regard to cost of maintenance, however, the newer scheme does not show so favourably for that of overhead lines through Russia, where ice collects on the wires and breaks them down. With regard to the probable ultimate employment of the lines, so far as through traffic between England and India is concerned, there appears no reason why both schemes should not be carried out, and the public are particularly interested in the establishment of both, for not only would the effect of competition stimulate both companies to offer the greatest possible convenience to the public; but it would also tend to keep the rates considerably below what they would be likely to be, under a monopoly. The value of the respective lines in a commercial point of view being, in times of peace probably nearly equal, there can be no hesitation in saying that politically the Anglo-Indian Company has overwhelming advantages. If a war with Russia occurred the telegraph through that country would be useless to us, while by means of the Anglo-Indian lines we could telegraph to every important station on the route from England to India. It is to be desired, however, that both schemes should be carried out, for their establishment will conduce largely to the interests of peace, as well as facilitate the carrying on of the commerce of the world.

Since 1836 there have been established throughout the world 160,000 miles of telegraph lines, comprising 400,000 miles of wire, and working through 14,000 stations. The total length of submarine cables laid is 19,923 miles.

MINES, METALLURGY, &c.

M. Fusell has devised an excellent way of discovering fire-damp in mines. Suppose a glass tube bent into the shape of a U, but with the thicker branch much shorter than the thinner one, and containing mercury. Let the shorter extremity be widened out like a funnel, and its orifice closed by a porous membrane. If the tube so prepared be brought into contact with any gas, the latter will penetrate through the membrane, mix with the air inside, and make it expand, thereby exercising a pressure on the mercury, which will thus be forced up into the thinner branch of the tube. Now, if this gas be fire-damp, its presence will be thus at once detected.

The Davy Safety-lamp.—It appears that the origin of the fire which destroyed an extensive paraffin wax-refinery at Rotherhithe, on the night of the 2nd ult., was a Davy-lamp with which the workman was provided. This lamp is said to have been carried into the vapour of a pan of heated naptha, and the workman was instantly enveloped in flame. It is hoped that a searching investigation will decide the important question of how far we may place confidence in the safety-lamp. Thousands of lives are dependent on the result of a thorough investigation of the origin of this fire.

An Improved Davy Lamp.—Mr. S. Higgs, jun., of Penzance, has invented a tube for the present Davy lamp, which has glass to protect the flame and allow it to be seen, and gauze to assist the Davy in withstanding the strongest gas or draught. The result of experiments in one colliery proved, it is said, a complete success.

Safety Lamps.—The notice of the experiments made at the Barnsley Gasworks, recently, tending to show that the best of lamps, including the "Geordie," was not to be depended on, has caused no ordinary amount of excitement throughout the South Yorkshire and other coal districts, and from all other parts of the country, communications have been received by Mr. Hutchinson relative to them. To still further elucidate the theory laid down that none of the so-called safety lamps are what their name implies, a considerable number of persons interested in the coal trade were invited to the Gasworks at Barnsley, on Wednesday afternoon, to witness some further experiments. Among those present were Mr. Woodhouse, of Derby, the eminent mining engineer; Mr. T. Dymond, the Oaks Colliery; Mr. Booth, Silkstone Fall; the principal stewards in the district, and several from a distance. The experiments were conducted by Mr. Hutchinson and Mr. Wilson, steward of Darfield Main Colliery. Several Clanny and other lamps were tested, and all of them exploded when subjected to a current of air when surrounded with gas. Mr. Lawtou, of the East Gawber Collieries, one of the oldest stewards in the district, brought a favourite Stephenson lamp with him, which he had been accustomed to use. On being subjected to the usual process, Mr. Lawton was much surprised to find his favourite lamp gradually warm, until it got red hot, and the gas burn a bright blue and green light, until it exploded the gas with a loud report in less than a minute from being put into the box. Several other lamps were then tested, all of which shared a similar fate, in most instances lasting a very few seconds. Nearly all those present were of opinion that the question of safety or none-safety of the lamps at present in use at collieries had arrived at that point where it was necessary to have so very important a matter thoroughly tested and decided. As the area in which the lamps have hitherto been tested has to some extent been confined, it is proposed to extend it, and also to obtain some of the gas escaping from the Oaks Colliery, where it is coming out at present at the rate of fully 1,000 cubic feet per minute, so that the most reliable data can be arrived at.

DOCKS, HARBOURS, BRIDGES.

Floating Docks.—We regret to hear of the sinking of the floating dock at St. Thomas's, in the West Indies. We believe this was the first effort to utilise the structure, which is of iron. It was built on the banks of the Thames, then taken to pieces, and reconstructed at St. Thomas's, where the dock unfortunately sunk in 33ft. of water, whilst the attempt was being made to dock the royal West India mail steamer *Wye*. We hope that the loss is only temporary.

The great enterprise of connecting the Atlantic and the Ohio by means of a ship canal between Kanawha and James rivers, in Virginia, has passed into the hands of a French company.

WATER SUPPLY.

The Loch Katrine Waterworks.—On Thursday morning, the 15th ult., at eight o'clock, the Lord Provost and the other members of the Committee of the Water Commission left Glasgow for the purpose of inspecting the new works at various points between the city and Loch Katrine, and ascertaining what progress has been made. These new works have for their object the laying down the piping, &c., for giving ten millions of gallons of water additional per day, making the supply equal to thirty millions per day. The committee went first to Blane Valley, where Mr. Charles Tough is the contractor for the laying down of the pipes at that place. They found that the operations were pretty far advanced and proceeding satisfactorily. They next drove to the Endrick Valley, where, in addition to the laying down of piping, a bridge is being constructed across the river Endrick. The contractor here is Mr. Robert Craig, who, they found, was getting through his work in an equally satisfactory way. The committee next drove to the top of Loch Ard and walked round to see the aqueduct bridges at Culegarton. They then went to see the progress made at Puchray Valley, in the laying of pipes by Mr. James Manwell, the contractor, and finally rode down on his tramway to Abertoyle, where they dined. So extensive was the ground to be traversed that the committee did not get back to Glasgow till one o'clock on Friday morning. But they had spent a very agreeable day, and were well pleased at the state in which they found the new works. We may add that the contractors for the pipes are Messrs. D. Y. Stewart and Co., St. Rollox, and that the whole of the works now in course of execution will cost about £45,000. The committee report it will be finished in such time as to enable them by next summer to draw thirty millions from Loch Katrine, instead of twenty millions as at present. The aqueduct, as is well known, was originally constructed for the passage of fifty millions, all that remains to be done to obtain that quantity being to lay down piping for twenty millions in addition to the thirty millions about to be brought into the city. If the consumption continues at the present rate the committee of the water commission will have to set about the necessary operations to get a supply to the utmost extent of their resources.

LIST OF APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF "THE ARTIZAN."

JULY 3rd, 1867.

1943 H. Clarke—Propelling vessels
1944 D. Davy—Steam and other hammers
1945 W. Thompson—Mouthpieces for cigars and pipes
1946 J. Salmon and G. W. Hick—Machines for ruling paper
1947 F. Leonardt—Combined lamp and match box
1948 J. McAdams—Printing from a chain of types
1949 W. E. Newton—Soda water
1950 A. E. Herrmann—Lubricating compound
1951 E. N. Brown—Carrying umbrellas

DATED JULY 4th, 1867.

1952 R. Hellard—Reaping and mowing machines
1953 T. Welton—Revolving shutter
1954 J. Ferreyt—New system of organs
1955 T. Vicars, T. Vicars, and J. Smith—Self-feeding smokeless furnaces
1956 P. F. Tranchat—Cutting fraises
1957 A. A. Champion—Chronographs
1958 H. Clarke—Propelling vessels
1959 F. Brady—Working railway switches and signals
1960 J. Bolton—Stands for croquet balls &c.
1961 W. Day—Applying metal sheathing to iron ships, &c.
1962 W. E. Newton—Breech loading firearms
1963 A. V. Newton—Combined ship's propeller and steerer
1964 I. Pick—Scarfs
1965 M. Henry—Raising and lowering heavy bodies
1966 H. Ruddick—Steam engines
1967 W. R. Lake—Illuminating gas

DATED JULY 5th, 1867.

1968 E. O. Greening and J. Atkinson—Washing, wringing, and mangling machines
1969 P. L. F. E. Roussel—Finger stall
1970 C. D. Abel—Elastic strap for garments
1971 J. McNaughton—Breech loading firearms
1972 H. C. Carver—Hoop iron fastenings for bales
1973 W. R. Lake—Metal tubes

DATED JULY 6th, 1867.

1974 W. C. Church—Steam and other motive engines
1975 F. Andrew and L. Clarkson—Printing woven fabrics, &c.
1976 W. R. Gorst—Wheeled vehicles
1977 R. Tiernan—Tobacco pipe
1978 T. C. Thomas—Watercloset fittings
1979 W. E. Newton—Constructing railways, &c.
1980 T. Morgan—Puddling iron
1981 H. B. Woodcock—Tyres for railway wheels
1982 T. Craddock—Invention of enabling persons to fly in the air
1983 W. Harris—Uniting and compressing sawdust, &c.
1984 W. Archer—Rotary engines and pumps
1985 C. Toft—Liquor frames, &c.
1986 J. C. Major—Production of heat by burning tar, &c.
1987 N. Thompson—Unions for connecting together tubes, &c.
1988 G. Severn—Refrigerators

DATED JULY 8th, 1867.

1989 J. Whitford—Ice making apparatus
1990 J. Capper—Chimney tops
1991 J. G. Tongue—Training climbing plants
1992 I. M. McGeorge and A. Paul—Plug valve
1993 J. Johnson, E. Shaun, and G. Ragg—Signalling apparatus
1994 Dr. J. M. Lorre—Preparing canvas, &c.
1995 J. Shanks—Lawn mowing machines
1996 W. Tasker—Thrashing machines
1997 A. Mather—Cleaning grain
1998 A. Turner and W. Helmsley—Elastic woven fabric
1999 N. Clayton and J. Shuttleworth—Traction engines
2000 M. P. W. Boulton—Engines worked by the combustion of inflammable aeriform, &c.
2001 N. Clayton and J. Shuttleworth—Slide valves suitable for steam engines
2002 W. Andrews—Haymaking machines

DATED JULY 9th, 1867.

2003 J. M. Gray—Marine steam engines
2004 J. J. Buckley and C. Hook—Manufacture of a gas
2005 W. E. Gedge—A regulating level
2006 G. Gnbillon—A process to prepare and preserve paper and tissues
2007 W. Avery—Cases for holding packets of needles, &c.
2008 A. Shanks—Making rivets
2009 J. Credland—Arrangement of flues of certain boilers for generating steam
2010 E. Crook and F. Crook—Crushing bones, &c.
2011 W. E. Newton—Rectification and purification of alcohol
2012 R. Smith—Mixing water, &c.
2013 W. R. Lake—Manufacturing cards
2014 W. Wood—Carpets and rugs
2015 W. S. Andrews—Telegraphic communications
2016 W. S. Andrews—Telegraphic communications
2017 H. English and J. Farrdon—Operating the shuttles of looms

DATED JULY 10th, 1867.

2018 J. E. Whiting—Suspension bridges, &c.
2019 J. S. Hood—Life buoys
2020 D. Collinge and J. Collinge—Looms for weaving sponge cloths by power
2021 H. B. Fox and J. T. Hall—Stopper for vessels
2022 F. Holmes—Pumps
2023 J. N. Paxman and H. M. Davey—Drying wheat, &c.
2024 G. Davies—Metallic eye for laces
2025 W. Heyes and W. Bevan—Self acting buckle or coupling
2026 W. L. Wise—Crossings for the permanent ways of railways
2027 W. E. Newton—Boring rocks, &c.
2028 G. R. B. Amott—Making bricks
2029 A. H. Brandon—Wood planing machines
2030 A. H. Brandon—Circular saw machine

DATED JULY 11th, 1867.

2031 J. Stirk and H. Bycroft—Refrigerators for cooling worts, &c.
2032 J. B. Fraser—Watches and chronometers
2033 J. S. Henderson and J. Macintosh—Cylindrical metallic cases
2034 J. H. Johnson—Refined sugar
2035 J. H. Johnson—Boots and shoes
2036 K. J. Winslow—Method of conveying the rotary motion to axles of steam engines, &c.
2037 B. Hunt—Bearings for machinery
2038 W. E. Newton—Permanent way of railways
2039 J. S. Burke and B. Burleigh—Construction of subaqueous works and foundations
2040 E. Hohenbruck—Breech-loading firearms

DATED JULY 12th, 1867.

2041 R. A. Kennedy—Doors and windows, &c.
2042 J. Nelson—Casting of hollow and other firebars
2043 J. B. E. G. Perrin—Smoke consuming apparatus
2044 E. H. Bernier—Raising and lowering persons and weights in mines
2045 F. Wilkins—Increasing the light or heat from carbonised atmospheric air, &c.
2046 J. Hargreaves—Manufacture of steel and soft iron from cast iron
2047 W. B. Haigh—Tenoning wood
2048 J. Kellett—Steam boiler and other furnaces
2049 G. Sinclair—Steam boilers and furnaces
2050 C. T. Higinbotham—Construction of furnaces
2051 J. H. Johnson—Mincing meat
2052 A. M. Clark—Life boats, &c.
2053 J. Pasfield—Safety valves
2054 D. M. Henderson—Lighthouse lanterns, &c.
2055 A. E. Herrmann—Compound to be used for igniting fires
2056 G. T. Bousfield—Corsets
2057 J. Laing—Fastening wood to iron
2058 E. B. Bigelow—Power looms

DATED JULY 13th, 1867.

2059 P. M. A. Laurent—Nautical compasses
2060 R. Sims and J. Prest—Horse rakes
2061 J. Walker—Spring boxes
2062 W. Drury and C. Westrup—Indicating numbers and names on doors of private houses
2063 T. Berney—Bending bars, &c.
2064 H. Bell—Heel tips and toe tips for boots and shoes
2065 H. Fletcher—Artificial fuel
2066 H. Duke—Reefing and furling ships' square sails
2067 E. T. Hughes—Self-acting vent peg
2068 J. C. Ramsden—Reeds and healds used in weaving
2069 J. Scott—Fire escapes
2070 J. G. Tongue—Ruling parallel, angular, and curved lines
2071 J. L. Norton—Drying grain seeds

DATED JULY 15th, 1867.

2072 I. Baggs—Washing basins, &c.
2073 T. Wrigley—Pulley and chain gearing
2074 G. Boehm—Combination of a bottle and compass
2075 F. D. Nuttall—Furnaces
2076 J. M. Hetherington and R. W. Pitfield—Preparing and spinning cotton, &c.
2077 J. Briere—Continuous self-acting condenser
2078 A. B. Ibbotson—Ventilating the interior of railway carriages
2079 T. Redwood—Preservation of meat and animal substance
2080 J. T. Skinner—Facilitating communication between the guard and the passengers in a railway train
2081 J. Fleming—Drawing beer, &c.

DATED JULY 16th, 1867.

2082 F. B. Vallance—Lamps for burning hydrocarbon, &c.
2083 H. G. Dunn—Saving life and property from fire
2084 J. Fraser—Printing consecutive numbers
2085 G. W. Hayes—Making paper
2086 J. Maunock—Cleaning boiler tubes
2087 W. McAndrew—Ginning cotton
2088 T. Pirie—Agricultural implements
2089 H. A. Bonneville—Permanent way of railroads
2090 H. A. Bonneville—Brushes

DATED JULY 17th, 1867.

2091 T. W. R. Webster—Loading cartridges
2092 T. Archer—Crushing and pulverising ores
2093 C. M. Tate—Button fastenings
2094 G. Weedon—Knife cleaning machine
2095 J. Schofield and J. C. Dawson—Drying barley
2096 A. de Smet—Communicating motion to the spindles of spinning machines, &c.
2097 J. Slater—Steam generators and condensers
2098 G. H. Daw—Cartridge pouches, &c.
2099 S. C. Lister—Consuming smoke, &c.
2100 J. H. Johnson—Treatment and purification of oils
2101 J. R. Swan—Steam engines
2102 C. King—Preparation of chocolate and cocoa
2103 W. R. Lake—Looms for weaving

DATED JULY 18th, 1867.

2104 N. J. O. Stubber—Treating flax, etc.
2105 W. Barningham and J. Thompson—Bending, punching, and straightening articles of metal
2106 A. Morton—Induction of fluids
2107 T. D. Walker—Heating the feed water supplied to steam boilers
2108 J. Palmer, J. Palmer, and T. Palmer—Screw wrenches
2109 W. Warden—Securing the more effectual obliteration of stamps
2110 G. T. Bousfield—Heating and cooking apparatus
2111 J. J. Harrison and E. Harrison—Looms for weaving
2112 R. T. Bradbury and T. Bottomley—Carding engines
2113 A. Paton—Letterpress and lithographic printing machinery

DATED JULY 19th, 1867.

2114 J. Hargreaves—Utilising certain materials obtained during the manufacture of steel and iron
2115 J. W. Butler and E. Edwards—Floating in and travelling through the air
2116 J. Rogers—Fastenings
2117 G. T. Bousfield—Bolsters for spinning machines
2118 P. H. Metham—Rudder

DATED JULY 20th, 1867.

2119 J. Saxby—Governing the action and movement of railway points and signals in relation to each other.
2120 K. H. Cornish—Entrenching tools
2121 J. Hargreaves—Production of compounds of soda from chloride of sodium, etc.
2122 T. Bromwick—Means of allowing the escape of superfluous carbon from casks of newly-made wine, etc.
2123 C. F. Whitworth—Preventing accidents at junctions, etc.
2124 A. Budenberg—Joints of pipes
2125 W. Taylor—Pipes for ventilating, etc.
2126 W. G. Cresmer—Ventilation of railway carriages, etc.
2127 A. Sezille—Treating dry peas
2128 R. Shaw and J. Stirk—Brickmaking machinery
2129 W. Potts—Suspending articles
2130 J. Hooper—Ventilators

DATED JULY 22nd, 1867.

2131 B. P. Franzoni—Hardening plaster, etc.
2132 T. A. Brietbaupt—Manufacturing extract and essence of hop
2133 H. Lea—Taps or valves
2134 W. R. Lake—Cleaning tubes
2135 J. Walker—Washing bottles, etc.
2136 H. von S. Sakunlunski—Transferring devices in lace, etc
2137 W. E. Newton—Brewing
2138 D. Welsh—Looms for weaving

DATED JULY 23rd, 1867.

2139 E. Tomlinson—Ornamenting, etc.
2140 J. H. Johnson—Nets and netting
2141 W. Dennis—Letter boxes
2142 H. A. Dufrené—Preserving iron from oxidation
2143 W. Easterbrook—Controlling railway points and signals
2144 J. Marley—Prevention of overwinding and falling of the cages used in mine shafts, etc.
2145 S. Bonsall—Spring bed bottoms
2146 S. Bonsall—Tanning, etc.
2147 Sir W. Thomson—Recording instruments for electric telegraphs
2148 W. Geeves—Cutting tenons

DATED JULY 24th, 1867.

2149 R. Lakin—Aerial locomotion
2150 W. Simpson and W. Howitt—Roofs of horticultural and other buildings
2151 W. Betts—Capsules
2152 H. Aitken—Coke
2153 R. B. Roden—Breech loading firearms
2154 T. Prideaux—Open fireplaces and stove grates
2155 A. M. Clark—Reciprocating motion

DATED JULY 25th, 1867.

2156 S. Turton and G. Holcroft—Facilitating communications between passengers, guards, and drivers of railway trains
2157 W. Howes and W. Burley—Securing lamps
2158 C. H. Murray—Moulding clay
2159 C. T. Moulan—Moveable joints for connecting metallic pipes and tubes
2160 W. E. Newton—Mould boards for ploughs
2161 A. Wilson—Casting of ingots
2162 J. Brown and W. Lillie—Reaping and mowing machines
2163 W. Wood—Producing and treating fibres from rags
2164 A. Mackie—Composing and distributing type
2165 T. M. Almond—Signalling at sea
2166 C. E. Broomann—Cast steel and its derivatives
2167 C. E. Broomon—Cartridge cases
2168 G. L. Barens and J. F. Ladougue—Breech-loading firearms and cartridges

DATED JULY 26th, 1867.

2169 J. Edge—Steam engines
2170 C. Silvy—Photographic apparatus
2171 R. Reid and E. H. Craigie—Improved reclining chair
2172 G. B. Northcote—Charging and turning cartridges
2173 E. Smith—Gas regulators

DATED JULY 27th, 1867.

2174 J. Smith and W. Schofield—Elastic rollers
2175 E. A. Rippingille—Separating the more volatile portions of mineral oils
2176 T. Reid—Digging potatoes, etc
2177 W. E. Gedge—Cutting slate, etc.
2178 E. T. Hughes—Constructing and propelling steam vessels
2179 W. E. Newton—Water and gas meter
2180 P. A. Robert—Gases for the production of light, etc.
2181 A. Jack—Digging potatoes, etc.
2182 H. Chamberlain—Hot blast stoves
2183 G. Franklin—Ships' compasses
2184 T. Jones—Locks and latches
2185 J. Wood—Manufacture and treatment of certain kinds of iron
2186 E. Ravenscroft—Lamps
2187 A. Macfie—Supporting lines for drying clothes

DATED JULY 29th, 1867.

2188 W. L. L. Leaver and A. Smalley—Lighting house and other fires
2189 T. Greener and W. Ellis—Manufacture of iron
2190 A. M. Clark—Projectiles
2191 W. R. Lake—Hulling rice, etc.
2192 G. Davies—Insulators for telegraphic wires
2193 P. G. B. Westmacott—Cranes, etc.
2194 D. Hedge and R. C. Witty—Making gas from petroleum, etc.
2195 J. H. Wyatt—Construction of studs, etc.
2196 B. F. Stevens—Burning petroleum, etc.

DATED JULY 30th, 1867.

2197 A. Holloway—Elastic clasp or lock
2198 A. Watt—Fertilising compost
2199 J. B. A. Menage—Moderator lamp
2200 J. Jones—Compound for extinguishing fires
2201 W. Gadd—Looms for weaving
2202 J. Haworth and E. Hamer—Rollers
2203 J. H. Brown and W. Bull—Hats, etc.
2204 A. Murray—Hauling vessels, etc., into deep water
2205 C. Mayo—Propelling and steering vessels
2206 A. James—Needle cases and wrappers
2207 S. M. Martin and S. A. Varley—Signalling upon railway trains

DATED JULY 31st, 1867.

2208 B. Dobson and J. Cocker—Machines for spinning and doubling
2209 B. Dobson and W. Slater—Carding engines
2210 M. Puddefoot—Plough
2211 M. J. Fearnley and C. Smith—Looms for weaving
2212 J. M. Hocking—Condensing noxious smoke and vapours
2213 G. Gordon—Manufacture of sugar, etc.
2214 W. R. Lake—Weavers' harness
2215 J. C. C. Azémar—Apparatus for holding pieces of paper, etc.
2216 C. E. Brooman—Firearms
2217 J. Saxby—Governing the movement of railway points and signals, etc.

DATED AUGUST 1st, 1867.

2218 W. Snell—Engraving machine
2219 F. A. Calvert—Cleaning and preparing fibrous substances, etc.
2220 J. H. Johnson—Umbrellas
2221 F. H. Holmes—Production of electric light
2222 D. D. Kyle—Signalling in and with railway trains
2223 R. B. Boyman—Propelling vessels, etc.
2224 J. Quin—Hose for conveying water
2225 R. Newall—Cases for needles and pins
2226 W. R. Lake—Pocket knives
2227 W. R. Lake—Breech-loading firearms
2228 W. Tranter—Firearms
2229 J. E. Nelson—Conveying passengers and goods through the air
2230 S. Higgs—Miners' safety lamps
2231 J. Birch—Manufacture of wax vesta matches

DATED AUGUST 2nd, 1867.

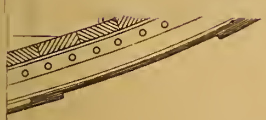
2232 J. Poole—Forming shafts, etc., with India-rubber surfaces
2233 F. L. H. Danchell—Preparing, shaping, and drying peat and other substances
2234 J. Edwards—Actuating railway points and signals
2235 B. Harlow—Apparatus applicable to the generation of steam, etc.
2236 J. H. Johnson—Hydraulic lifts
2237 E. T. Marler—Clarifying sugar
2238 J. Dewar—Preserving substances for food
2239 E. A. Kirby—System of dispensing medicines and preparing drugs therefor
2240 W. Horton—Forge hammers
2241 T. Allen—Submarine telegraph cables
2242 J. G. Tongue—Brakes for cotton lappers

DATED AUGUST 3rd, 1867.

2243 J. Smith—Cleansing fibrous materials
2244 J. Elce and T. Elce—Machinery for spinning and doubling
2245 C. D. Abel—Combined gas and air engines
2246 R. Bewley—Rotary pumps
2247 C. Touaillon—Means of utilising all the parts of all sorts of feathers
2248 J. Russell—Flattening and straightening saws, etc., during hardening
2249 A. Budenberg—Indicating and registering the pressure of steam in steam generators
2250 J. F. Fenton and F. Fenton—Coffee injector
2251 W. R. Grace—Harrows
2252 J. T. Hatfield—Watch cases
2253 G. W. Dinsdale—Traps for water closets, etc.
2254 W. W. Hughes—Propelling vessels
2255 W. Wilson—Felting machines

DATED AUGUST 5th, 1867.

2256 J. Argus—Lamps
2257 L. V. Hue and C. Roziere—Moulding subjects in glass
2258 J. Dale—Refrigerator for cooling wort
2259 W. J. Pughsley—Obtaining sulphuric acid
2260 A. C. Bamlett—Reaping and mowing machines
2261 C. de Negri—Reducing wood to shreds



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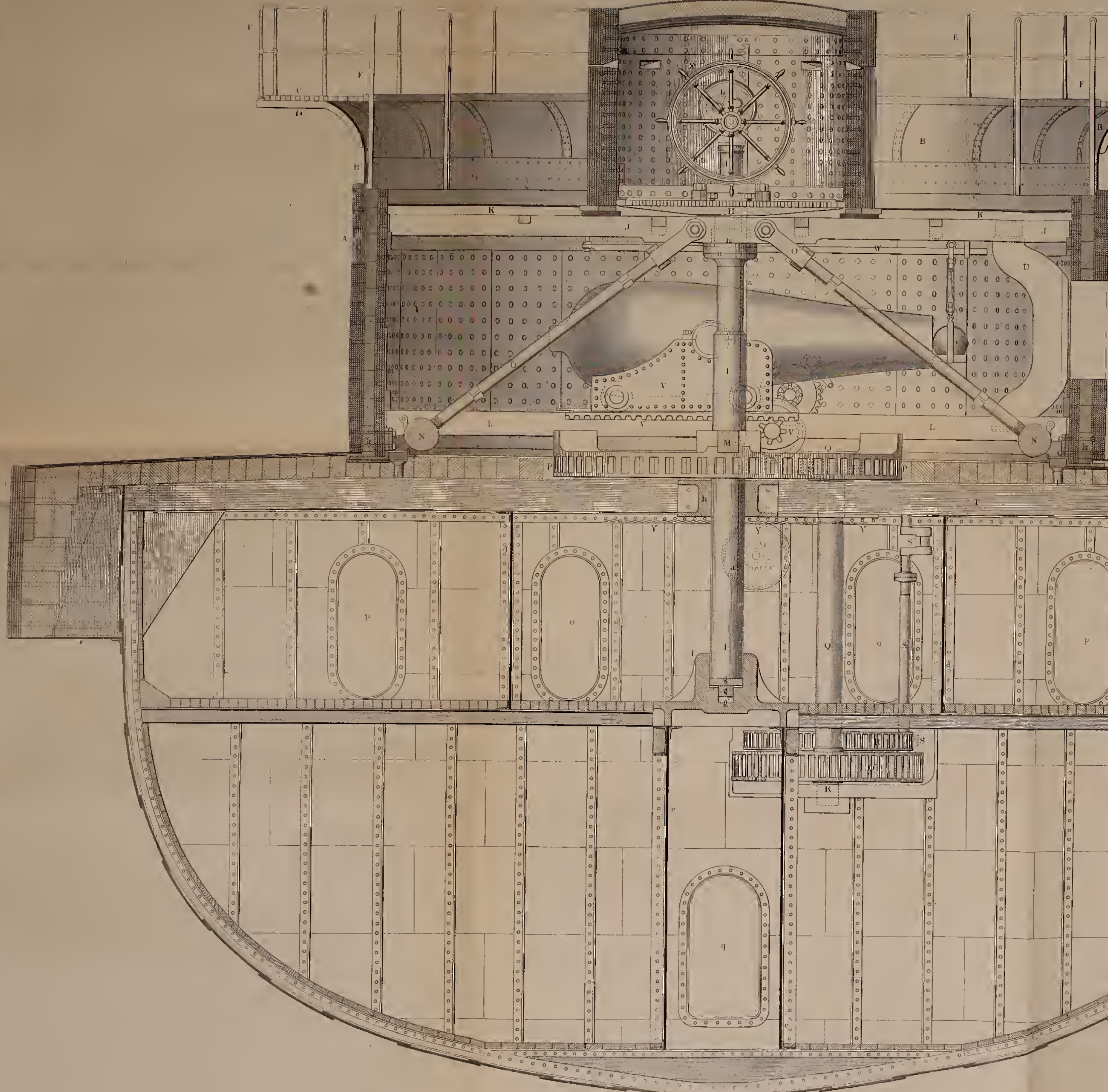


UNITED STATES

IRON CLAD SCREW STEAMER

DICTATOR

DESIGNED BY JOHN ERICSSON, 1862

W. Smith C.E. direx

FIG. 3.

HOWARD'S NEW PATENT SAFETY STEAM BOILER.

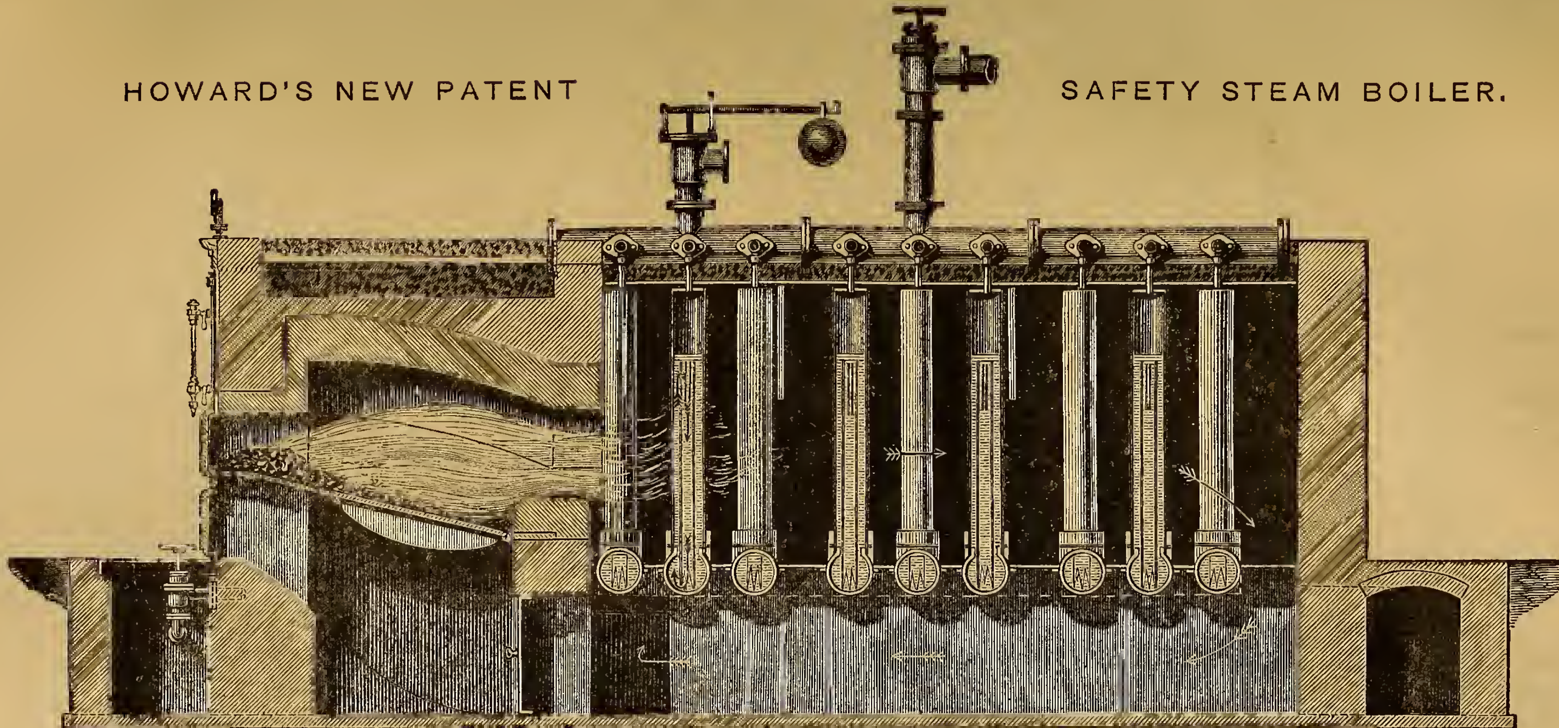
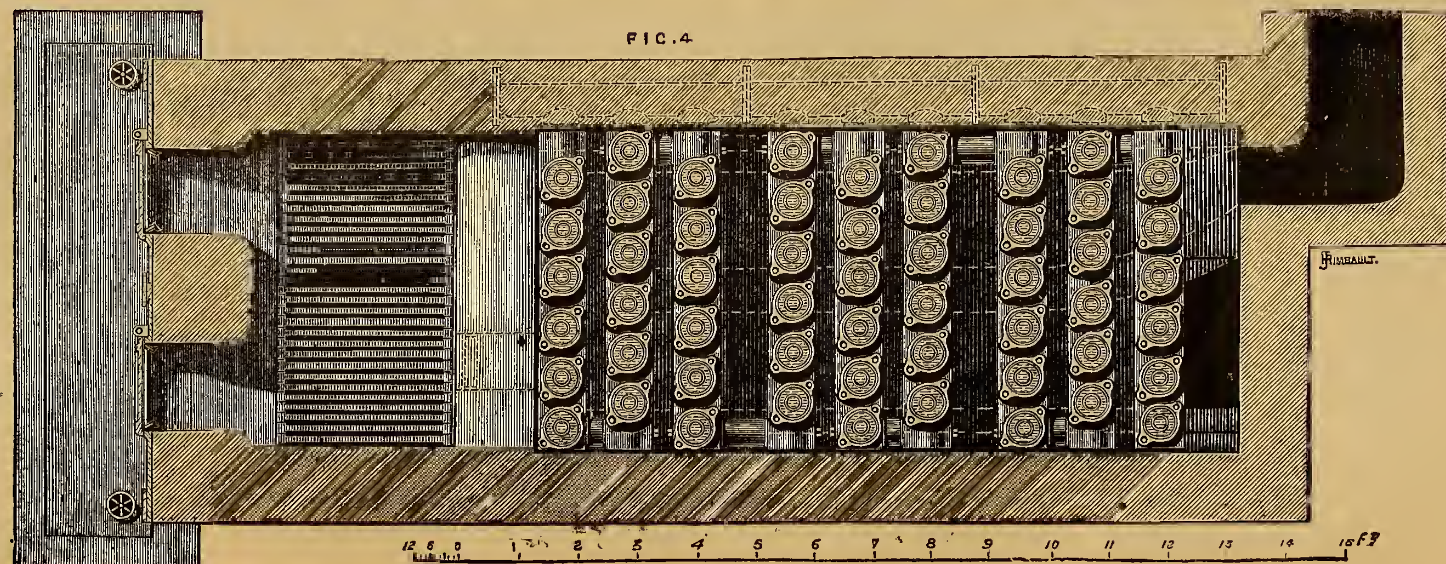


FIG.4



THE ARTIZAN.

No. 10.—Vol. I.—Fourth Series.—Vol. XXV. From the Commencement.

1st. OCTOBER, 1867.

UNITED STATES' MONITOR "DICTATOR."

(*Illustrated by Plate* 320.)

The subject of war vessels has, perhaps, created a fiercer and more lengthened war on paper than anything else, and the battle of ironclads *versus* wooden ships, turrets *versus* broadsides, has been fought with an energy that nothing but the immense importance of the subject can justify. The almost fabulous amount of money spent by the various Governments in the world, and our own Government in particular, in making experiments and building vessels of almost every conceivable form, might be excused for the same reason if the question as to what was the best style of vessel for war purposes had been solved. The only thing that seems to have been decided, is that iron-plated vessels must be used, but the thickness of the plates and the shape of the vessels seem to be as undecided as ever. The advocates for broadside ships having armour limited in thickness, and the advocates of turret ships or monitors with immensely thick armour, are about equally numerous.

Monitors are undoubtedly excessively ugly, even to landsmen, and the disgust with which they are contemplated by naval officers may be imagined, if not described; nevertheless, to engineers, who as a rule look principally, if not entirely, to utility, there are many points which tell in their favour. It is to the versatile genius of Ericsson that we owe the creation of the monitor class of war ships, and in which he seems to have had this object in view, viz., with a light draught of water to combine the greatest possible power of aggression and defence under the particular circumstances in which his adopted country was then situated. To construct a vessel with its sides high out of the water that shall be invulnerable is evidently an impossibility, unless it should be of an enormous size and of excessive draught; but in this case the draught was limited, and, consequently, the only way left open was to cut down the sides. This he did most effectually by cutting them down almost to the water's edge, only leaving 16in. of the side of the ship above water, and placing at or near the centre of the vessel a revolving turret.

The *Dictator*, of which we give an engraving, Plate 320, draws 20ft. of water with 800 tons of coal on board, the cylinders are 100in. diameter and 4ft. stroke, with a screw of 34ft. pitch; the boilers have 1,128 sq. ft. of grate surface, and upwards of 32,000 sq. ft. of heating surface. Her beam is 50ft., her extreme length 314ft., and she is one of the sharpest vessels afloat. When this vessel was built, it was only considered fit to navigate the rivers, and, in fine weather, the coast of America; in fact the idea of going a long voyage was ridiculed by nautical men in general. Since that time, however, similar monitors have gone round Cape Horn, and in The Artizan of last month an account was given of the successful trip across the Atlantic of the *Dunderberg*, and which has been purchased by the French Government, thereby showing that it is not only Americans that have faith in the sailing powers of such vessels. It is not intended to assert that the fact of one or two successful voyages is by any means a proof of their entire sea-worthiness, yet it disproves the oft repeated assertion that such a voyage was an impossibility.

The section of the *Dictator* given in Plate 320, shows at one view, nearly all the leading points of the monitor system. The almost entire submersion of the hull, the thick side armour and armour backing, convey the idea of absolute impregnability.

It will be seen that the pilot house is placed above the turret, it was at first fixed at the bow of the vessel, but when in action the helmsman and gunner require to be under the immediate direction of the captain, and, therefore, Ericsson managed very ingeniously to fix a stationary pilot house above the rotating turret, by which means the commander is enabled to direct the helmsman at his side, and the gunner below, while he is looking at his adversary.

Referring now to Plate 320, A, is the turret, 24ft. inside diameter, 9ft. 6in. high, and 15in. thick, composed of two separate cylinders formed of plates 1in. thick lapped and rivetted together. The outer cylinder, composed of six plates, was built on a staging above the inner one of four plates, and after completion was slipped over it. The annular space of 5½in. between the cylinders, is filled with segmental slabs 5in. thick, made of the best malleable iron. These slabs were made only 11½in. wide, in order to save time. B is an extension attached to the top of the turret composed of plate ½in. thick, bent outward in the form of a trumpet in order to throw off the sea in bad weather. C, is a wooden grating extending round the turret extension, supported by brackets D, bolted to the latter at intervals of 3ft. E, stanchions for supporting a rope rail carried round the wooden grating. F, stanchions for sustaining an awning in fine weather. G, the pilot house, 8ft. inside diameter, 7ft. high, and 12in. thick, formed of two separate cylinders, each composed of six plates 1in. thick lapped and rivetted. After completion, the larger cylinder was forced over the smaller one. The roof is composed of three plates 1in. thick, covered with 8in. thickness of wood, and an outer plating 1in. thick. The roof is inserted below the top of the cylinders, and is thus protected from shot, both cylinders being pierced with eight elongated sight holes. The weight of the pilot house is supported by a broad wrought iron cross piece H, secured to the circumference of the house by angle irons, this cross piece resting on a collar near the upper end of the stationary vertical pillar I, round which the turret turns. The floor of the pilot house consists of wooden gratings provided with grated hatches moving on hinges. J, is the upper turret beam of wrought iron, 11in. deep, 8in. thick in the middle, sustaining rafters which support a series of bars K, 4in. deep, 3in. thick, placed 2½in. apart, on the top of which are placed perforated plates 1in. thick covering the entire turret. L, are the gun slides, four in number, 10in. deep by 4in. thick, of wrought iron, the ends of which rest on plate rings secured to the turret, their middle resting on the lower turret beam M. N, is a cross piece of wrought iron, suspended under and let into the central pair of gun slides, and into which are tapped the diagonal braces O. By means of these braces O, the entire weight of the turret may be suspended on the collar n' of the turret shaft. P, is a spur wheel bolted to the underside of the gun slides and lower turret beam, and worked by a pinion Q on the vertical shaft Q′, at the lower end of which is the spur wheel Q″, driven by a pinion on the axle R, and on which is fixed the spur wheel R′. This spur wheel is in turn worked by the pinion S, on the lower end of the shaft S′, which is provided with a crank S″, and turned by an engine consisting of two cylinders 12in. in diameter, and 16in. stroke, placed at right angles, and bolted to the under side of the deck beams T. U is a port stopper for preventing shot from entering the turret, composed of a massive block of wrought iron bent in the form of a crank, provided with bearings, in which it may be turned into such a position as to admit of the gun being rolled out, while, when turned into another position, it closes the port. V, is the gun carriage; V′, a rack on the under side of the same; V″, a pinion for moving the gun on the slides, and by means of which, combined with a friction coupling the recoil, is

checked, W, is radial sliding bar for passing the shot into the muzzle of the gun without handling; X, is the steering-wheel, and Y, the double barrel for the steering chains Y′, which run upon rollers under the deck beams. *a* is a bar of steel, $2\frac{1}{2}$in. square inserted in a groove formed on the port side of the turret shaft, provided with cogs on the opposite sides, by raising or lowering which, by means of a train of wheels in the steering box *b*, the chain barrel is worked through the pinion *c*. *e*, fore and aft bulkheads to support the weight of the turret and turret shaft, strengthened with angle-irons, 6in. by $4\frac{1}{2}$in. placed 18in. apart, upon which rests the cast-iron saddle *f*. *g*, a key for regulating the height of the turret shaft above and below which are plates g' and g'' of composition metal to prevent cutting. *h*, is a cast-iron bearing for giving lateral support to the turret shaft into both of which square keys are let in, to prevent the shaft from turning. *i*, is a wrought-iron plate, polished on the top side, secured to the deck; a corresponding plate of composition metal, with a projection on the inside, being fitted under the base of the turret with which it revolves. This composition plate does not extend under the outside cylinder of the turret which is supported by being bolted to the base ring *k*, as shewn in the engraving; underneath this part of the turret, the space is filled with oakum or similar material. Scupper holes *l*, are provided for carrying off any water which may enter the turret between the base plates in a seaway. Plates *m*, are riveted to the four inside courses for sustaining the upward pressure of the gun slides when the diagonal braces are screwed up, composition rings *n*, being fitted between the upper turret beam and the collar n' of the turret shaft, nearly the entire weight resting upon this ring when the turret shaft is fully keyed up. Doors *o*, in the upper transverse turret bulkhead afford communication between the berth deck and the turret chamber, the doors *p*, forming communication to the after part of the ship and doors *q*, in the lower bulkheads to the boiler room and coal bunkers.

The armour shelf *r*, extending entirely round the ship, is composed of plates 4ft. wide by $\frac{5}{8}$in. thick rivetted to the hull and supported by brackets r' 5ft. deep and 28in. wide at the bottom, placed at intervals of 3ft., and secured to the hull by angle-irons and rivets, the armour shelf being secured in a similar manner. The armour backing is composed of vertical blocks of oak supporting five longitudinal timbers in the manner shown in the plate, and secured to the shelf bracket by blunt bolts s', and to the hull by screw bolts s''. The side armour *t*, is 6ft. wide, composed of six plates 1in. thick blunt bolted to the backing, no through bolts whatever being employed. Between the side armour plates and the wooden backing, longitudinal stringers or slabs of wrought iron $4\frac{1}{2}$in. thick are introduced, through which the blunt bolts pass. These longitudinal slabs or stringers give great power to the ship when acting as a ram.

It is clear from the above description, which is condensed from the new edition of Bourne's admirable "Treatise on the Screw Propeller," that the *Monitor* is capable of improvement, the most obvious being the substitution of solid for built up armour plates, which in that case were only excusable by reason of the exigencies of the times. The immense improvements also that have been effected in the manufacture of artillery, would necessitate considerably heavier armour throughout, and, in fact, one of the principal arguments in favour of this system is that, by its adoption, vastly heavier armour can be carried than is possible for a vessel of the usual build. Even if it should hereafter be proved that this description of vessel is not a trustworthy sea-going ship, still it would be invaluable as a means of defence for our coasts and harbours. We are also indebted to Mr. Bourne for the plate illustrating this interesting subject.

HOWARD'S PATENT SAFETY STEAM BOILER.

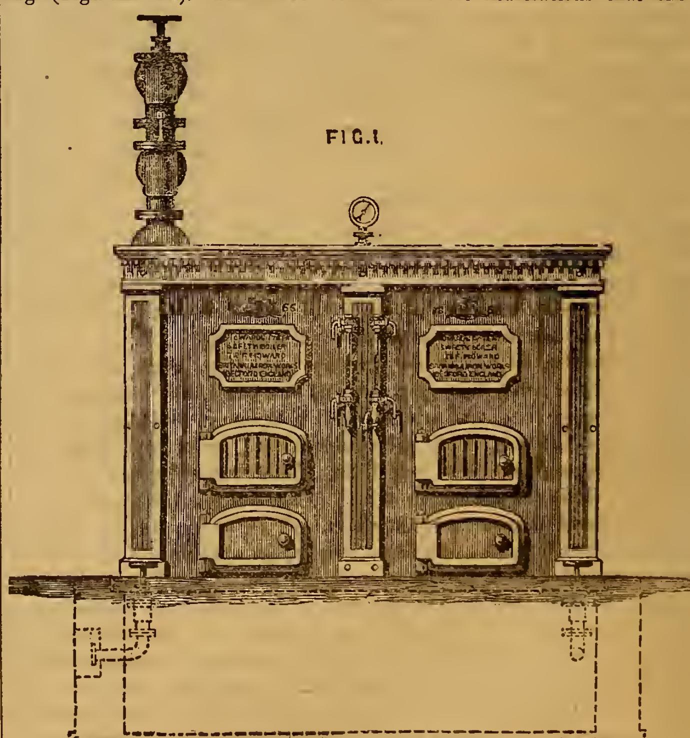
(*Illustrated by Plate* 321.)

This boiler belongs to that description known as the tubulous or water-tube boiler, in which the fire plays on the outside of the tubes. It might, perhaps, be better designated as the true tubulous, in contradistinction to that type of water-tube boiler in which the tubes are employed in conjunction with an ordinary shell, as, for instance, in many American marine boilers, whereas, in this case there is nothing but tubes to constitute the entire boiler. Many attempts have been made at different times with varied success to generate steam upon this principle, though it is questionable whether some of the designers were at the time fully aware of the advantages resulting therefrom, and consequently failed in some essential qualifications; while in many of the boilers there was too much complication, which increased the expense and the liability to derangement to such an extent as to render the design practically useless. Until lately, it seems that the principal object in designing this description of water-tube boiler was for the purpose of economising weight, being intended for steam carriages or road locomotives, a few also were specially designed for working at very high pressure, but it does not appear that it was ever presumed that they could supersede the Cornish or any other recognised type of stationary boiler for ordinary purposes.

For many years Messrs. Howard of Bedford, sharing, we presume, the opinion of most engineers, employed Cornish boilers for the purpose of supplying steam to their engines; but, as the feed-water was drawn from the river Ouse, which at certain seasons is excessively muddy, and at all times throws down a large quantity of deposit, they were found to be a constant source of annoyance and expense from the frequent leakages and consequent repairs.

As a natural result, Messrs. Howard turned their attention towards designing a boiler more suitable to their requirements, and after many preliminary experiments, constructed a boiler of 40-horse power with which they replaced a Cornish boiler of the same nominal power. After giving it a fair trial, they were so satisfied with it, that they replaced the other Cornish boiler by one similar to that already at work, and of which we give a longitudinal elevation and plan in Plate 321 of the present number, as also front and sectional elevations in the accompanying engravings (Figs. 1 and 2). It will be seen from these illustrations that the

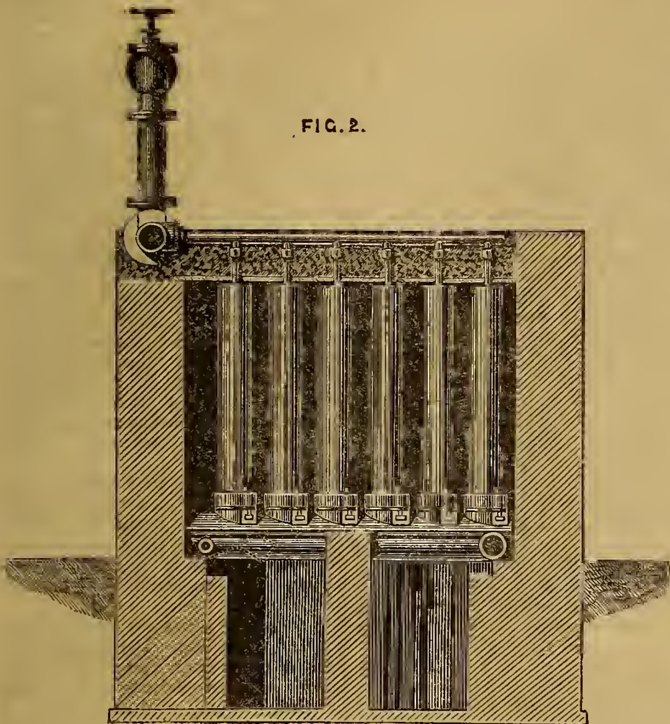
FIG. 1.



boiler is entirely made up of small parts or tubes, one advantage of which is, that should any part burst, it could be of no more importance than the collapsing of a tube in any other boiler—an occurrence, as every engineer knows, by no means rare. We do not mean by this to insinuate that it is at all likely that any portion of this boiler should give way, as it is

evident, that in this case the pressure is from the inside of the tube, and it is, of course, perfectly well known what an enormous pressure a tube will resist when that pressure tends to burst it, compared to its power of resistance to collapse.

FIG. 2.



In this boiler the tubes, which are of wrought iron, have the ability to resist a pressure of upwards of 2,000lbs., and the entire boiler and steam connections are proved to a pressure of 500lbs.; it will, therefore, be seen that the chance of bursting is very small indeed. Still, as we said before, should such an accident occur, the result would be comparatively unimportant or similar to the opening of a valve—a rush of steam and water into the heating chamber, a sudden lowering of the steam pressure, and possibly, the extinction of the fire.

On referring to the engravings, it will be seen that the boiler consists of a series of vertical tubes disposed in transverse rows in a flue or "heating chamber," these rows being so placed as to break joint, so that the heated products of combustion passing between the first row impinge directly against the tubes in the second row; the third row being placed in line with the first, receive in their turn the full action of the heat passing between the second row, and so on. This method of placing the tubes has only recently been adopted, the original boilers having the tubes all in line. The results given by this plan have been very good, as Messrs. Howard state that it was found that thirty-six 7in. tubes thus arranged were as efficient as eighty-one 5in. tubes arranged in line, the surfaces being in the proportion of about 3 to 5.

The tubes in this boiler are 7in. in diameter, and 4ft. 6in. long, of wrought iron, welded and closed at the upper end by flat plates welded in. Round the lower end of these tubes a stout ring of cast iron, with two projecting lugs, is firmly fixed, by roughing the end of the tube, and then placing it in a mould, and casting the metal round it. These lower ends of the tubes are then connected in rows, by means of a cast iron transverse tube, strengthened by perforated partitions.

In order to receive the vertical tubes the upper part of this cast iron tube is built up flush, or a little higher than the top, where they come, and a groove is turned out to receive the wrought iron tube which is made to project below the ring cast on it, and which is turned up to fit the groove. Recesses are also cast in the horizontal pipe to correspond with the lugs on the vertical pipes, into which are fitted gun metal nuts, so that two bolts on opposite sides, passing through the lugs and into the gun-metal nut, hold the two pipes firmly together; a water and steam tight joint being made by first placing a ring of soft metal in the annular groove. It will, of course, be seen that such a joint may be readily made or broken at any time, and as frequently as required. The upper ends of the vertical tubes are connected to a horizontal pipe by means of short pieces of lap welded piping, for the purpose of carrying off the steam to the main steam pipe or steam chest, on which are the safety valve and usual fittings. By this arrangement every part of the boiler is free to expand or contract as far as necessary, and consequently the most fruitful source of leakage with all its concomitant evils is obviated.

Upon referring to Fig. 3, it will be seen that advantage is taken of the principle of circulating tubes, each vertical tube having a smaller one within, extending from a little above the water line downwards into the transverse connecting pipe, upon which it stands. The bottoms of these tubes are vandyked to allow free egress for the water, while the tops have slots cut in them, extending a short distance down, for a similar purpose; feathers are also provided for keeping them in the centre. The transverse pipes, upon which the bottom of these circulating tubes rest, receive the feed water direct, and consequently a thorough circulation of water through the boiler is kept up; the circulation being so rapid that, with proper attention to the blow-off, no sediment can adhere.

The setting of the boiler is so arranged that no joint of any kind is exposed to the direct action of the fire or heated products of combustion. In order to carry out this object, the transverse cast iron pipes rest upon side walls and also, a central wall which forms a wheel draught; between these pipes cast iron plates are laid, and upon these are laid bricks and fire-clay to such a height as to protect the joints with the upright tubes, the products of combustion heating the underside of the transverse pipes on their way to the chimney, as shown in Fig. 3. In order to protect the upper portion of the boiler from too great a heat, screens or baffle plates of fire-clay are placed so as extend across the tube chamber, and somewhat below the water level, and by this means the greatest heat of the furnace is caused to act directly upon the water in the upright tubes.

Messrs. Howard state, that in economy of fuel this boiler far exceeds the Cornish boiler, the following being the result of one of the trials, and which may be taken as a fair sample:—

Cornish Boiler.—Duration of experiment, 2hrs. 57min.; coal used, 11cwt. 2qrs.; water evaporated, 520 gallons = 5,200lbs., or 4·03lbs. of water per 1lb. of coal.

Howard's Boiler.—Duration of experiment, 4hrs. 27min.; consumption of fuel, 10cwt. 2qrs.; water evaporated, 750 gallons = 7,500lbs., or 6·38lbs. of water per 1lb. of coal, similar coal (cobble) being used in each case. Upon testing the heat in the flue leading to the chimney, the pyrometer indicated 200° less than in the flue of the Cornish boiler.

It will be seen that the fire-clay screens or baffle-plates before mentioned, for the purpose of deflecting the flame from the top of the boiler, do not prevent a considerable amount of heat from acting upon the steam spaces. This arrangement is for the purpose of drying and superheating the steam.

Another advantage is claimed for this boiler, which certainly seems to be of great importance to those who have steam machinery abroad, and who have experienced the difficulties and expenses attendant upon obtaining a boiler of any considerable power, in consequence of its excessive weight and size, viz.:—about three men are sufficient to move and fix the boiler without pulley-blocks or tackle, and the largest piece will pass through any common doorway; and for the same reason it can, of course, be transported from place to place with great facility, while, as may be seen from the engraving, the brickwork setting is of the simplest character, being all straight work.

MACHINE TOOLS, CLASS 54, IN THE PARIS EXHIBITION.

By J. Anderson, Esq., C.E.

(*Continued from p.* 200.)

Shultz, of Vienna, has a fair sample of a machine for cutting the teeth of wheels for clockmakers, or for other small machinery. Why they have chosen the old-fashioned dividing-plate instead of the usual dividing-wheel it is difficult to understand, the latter being not only better, but also less expensive. In other respects this tool is well constructed.

The Imperial Arsenal at Vienna supplies a very passable collection of machines for wood and metal, which are worth careful examination, and all the more because they resemble the American style instead of the English. One of these machines is for forming parallel or taper wooden poles of any description; it may even be arranged to produce irregular surfaces. This machine is of the lathe class; its peculiarity consists of two guides placed upon the bed, which are adjustable to any angle, or may be fixed parallel with the axis of the lathe. The cutting tools are held in a small portable instrument, which embraces the guides in such a manner as to push the cutters out or in as the instrument is pushed along, and thus the form of the guides is transmitted to the poles.

Another good machine, for cutting the spokes of wooden wheels for gun-carriages, is shown; the pieces of wood are laid side by side on a sliding table and passed under revolving cutters by self-acting motion. This machine does not admit of the variety of form which is secured by the Blanchard arrangement, which is now used in England and America; but, if the form of spoke is adapted to the shape which this machine can produce, it is less costly than the other.

A most ingenious machine is also shown for dovetailing and other operations connected with boxmaking; revolving chisels are employed, and by means of self-acting arrangements the table that holds the wood under operation is made to tilt first on one side and then on the other, so that the dovetailing becomes as simple as plain cutting. A machine for rifling gun-barrels is worth looking into, it operates upon four simultaneously, and is, at the same time, comparatively simple and practical.

Russia shows comparatively little in class 54; there is, however, one lathe of very passable construction, in which an additional movement out of the usual course in tools of this nature is shown—no doubt intended for some special purpose. A cutting instrument can be set to work round the article fixed in the centres, or otherwise.

In the Swedish annexe a most ingenious pair of screwing stocks is shown, whereby screws of any pitch or diameter can be made with a single cutting instrument, and with equal facility.

America.

Passing to the American department, the English student will find many peculiarities which deserve his best consideration, more especially in the display made by Sellers, of Philadelphia (7). The first impression will be the striking resemblance to English tools—bold, massive, yet graceful outline, and altogether different to the usual American type; but a closer examination will reveal many novelties, and show that they can think for themselves in the arrangement of every detail. They exhibit a machine for cutting the teeth of wheels, which, when once set in motion, is perfectly automatic until it has gone entirely round, when it stops of itself and calls for the attendant. The mechanical arrangements that are introduced in order to effect the various movements necessary to accomplish so much may seem complicated, but a closer inspection will show that such is not the case. If, however, the young English student should think otherwise, let him set to work and devise a more simple combination, so that we may also have automatic machines for the same purpose.

The two lathes shown are, in their general features, a good deal after the Manchester school; still they have some original arrangements of great merit—one is the mode of communicating the rate of self-acting feed motion. In lathes generally it is done by means of wheel-gearing, or by cone pulleys of different sizes, hence some trouble is involved in changing, and any change that can be made will depend on the relative sizes of the wheels or pulleys. In Selley's lathe no wheels or pulleys are used, but a plain disc is substituted, a portion of which is placed between two other revolving discs that are gripped together with sufficient force to communicate motion; hence by the simple movement of a handle the relative position of the discs is altered, the rate of motion being dependent on the point of distance from the centre at which the motion is given off or received. Another peculiarity in these lathes is the manner in which the point of the cutting tool is raised or lowered in order to be placed in the best position for its work without requiring any packing or other makeshift; here the cutting tool rests upon a rocking bed, which may be adjusted with the utmost precision to bring the tool to the proper level. Another trifling feature in these lathes is the conversion of a portion of the bed into a sort of press or cupboard for storing away the tools and other spare gear, so as to avoid the litter so often observable; this is not an original notion, for it has been done in England to some extent, but it is not generally done. Their two planing machines will compare with any tools in the Exhibition, and from the peculiarities will probably give rise to some discussion.

One of these planing machines is small, and on the usual arrangement of placing the articles to be planed on a movable bed, the cutting tool being stationary. The other machine is of grand proportions, and arranged for the tool to move and the article remaining stationary. Both deserve a special notice. The small machine is cleverly arranged, especially in the manner of giving motion to the bed. Under the bed is fixed a rack in the usual fashion, but instead of being worked by a pinion with driving-shaft at right angles, as in other machines, the shaft is placed upon the skew, so as to place the angle surface of a worm parallel with the teeth of the rack, the worm meanwhile running in oil. By this simple arrangement they combine the advantages of the screw and the rack, and the strong construction of bed which this arrangement admits of, is also a notable feature. In the construction of the large machine the table for holding the article to be planed is part of the great bed, and is constructed with a rack along both sides. The upper part of the structure is much in the ordinary form, consisting of two brackets strongly braced together at the top, and furnished with the usual transverse slide, with tool-holder and self-acting motions. The whole of this part of the apparatus slides upon the bed, and receives motion at the top by means of a peculiar compensating band arrangement, which, by means of a transverse shaft, gives motion to vertical shafts, one at each side, which gear by pinions into the racks on the edge of the table. The mode of preventing this sliding framework from rising is ingeniously arranged, and all the details have been well matured and carefully carried out. The idea of moving the tool instead of the article, when dealing with large masses, is not new. Even twenty-five years ago Mr. Nasmyth had constructed such a tool for Mr. Fairbairn, and since that time others have been constructed of considerable merit. But the writer does not remember to have seen a machine of this character so likely to meet with general acceptance as the one now referred to.

Sellers also exhibit a steam-hammer, with a new mode of manipulating the steam-valve, which is well worth attention. This is accomplished by means of an angular groove upon a continuation of the piston-rod working within a steam case above the cylinder, a pin upon the valve-motion lever is inserted into the groove, and it is so arranged that by means of a convenient handle the position of the lever can be altered, and so made to work the hammer, self-acting, to any required height.

The same firm have a fine display of screwing apparatus, entirely of a new character, and all constructed on sound principles. The great advantage which we, as a nation, have derived from what was done by Mr. Whitworth in regard to a uniform system of screw threads is now fully recognised by all; still it is confessed that it would have been better if Whitworth had gone one step further by entirely discarding all existing screws, and carefully attempted to work out the best system of screw-threads that it was possible to devise. That is what is now professed to be accomplished by Sellers, and which has been adopted as the national standard screws in the United States. By this system screws of all sizes are the same in the form of the thread, namely, an angle of 60 deg.; six cutting tools for any size of screw, if placed together, will form a complete circle. The depth of the thread, the amount to be taken off the sharp point of the cutting tool, are all derived from the diameter or the pitch, or from each other, on a well-defined principle. These screws, when complete, are what is technically termed "flat top and bottom," and although this system may be objected to by those who are accustomed to and prefer the "round top and bottom," yet it is very evident that the flat gives greater facility for measuring the diameter with extreme accuracy.

The screwing stocks and dies which they exhibit are well worth studying carefully; the mode of compressing the whole of the dies upon the bolt simultaneously is probably the most simple yet devised, and equally perfect as a mechanical arrangement. There is also to be seen an interesting collection of parts of shafting, couplings, hangers, pulleys, and other similar articles—all exceedingly simple, of cheap construction, and no doubt most effective.

This firm is said to be the most extensive manufacturers of such articles in the United States of America, and their display is well worth the unbiassed study of our millwrights, and of all others who are interested in such constructions. Altogether, the collection exhibited by Sellers probably contains more originality than that of any other exhibitor in Class 54 in this Exhibition.

Harris (9) has a lathe of the recent American type, quite a specimen in its way, but not such as to commend itself greatly to English notions. It contains, however, one point of interest—namely, an arrangement for adjusting the vertical height of the point of the cutting instrument in regard to the centre of the lathe. In this instance an inclined plane is resorted to, and it may be instructive to compare this method with that of Sellers, which is close by. It also shows us how much attention the Americans are paying to such minute details, well knowing that such points are of more real economic importance than matters of greater pretension.

The American Tool Company (4) exhibit only one tool, a lathe, intended for brasswork—cocks, gauges, and similar articles. Although, to our ideas, this lathe may seem rather flimsy in its general structure, nevertheless, it is a perfect study in itself, and will repay a most attentive inspection. The combination of handy arrangements for boring or turning parallel or at

any angle, and the facility with which screws can be formed under any conditions, is truly admirable, and deserves the closest scrutiny. Its system of chucks, its swivelling arrangements of shifting headstock with square spindle, and other peculiarities, as well as the working bar for screw-cutting, together with its exquisite workmanship, place it among the gems of the Exhibition.

Brown and Sharp (5) exhibit a machine for making any description of screw out of the rough bar, which cannot fail to attract attention. When the screw to be made is once determined upon, every instrument necessary to its production is placed in suitable holders therein provided; the wire or bar passes through the centre of the revolving spindle, when tool after tool is successively brought into operation, and screws of perfect identity are thereby produced with facility. America has done more for this kind of machine than any other country. The system originated in the great clock manufactories of that country, and was introduced into England by Mr. Hobbs, after 1851, for his lock-making, and afterwards it was brought into some of the operations of the War Department; but in no previous example has the system been so well developed as in this machine. The same firm also show a milling, or, as it is frequently termed in England, a shaping machine, in which circular cutters are employed. This class of tool is the great feature at the Enfield small-arms factory, and is much more used by engineers and machine-makers in America than it is in England. The difficulty of keeping up the sharpness of the cutting instruments is much overrated, now that there are proper means for sharpening without reducing the temper.

Bement and Dougherty (6) show some good machine tools, all with certain points of special excellence. One is a horizontal boring machine, which has a clever arrangement for giving different rates of self-acting feed motion to the boring bar; a number of wheels of different sizes run loosely upon a spindle, but by touching a small handle that passes through its interior any one of the wheels is at once connected and gives a rate of motion accordingly. The table of this machine is also conveniently arranged for fixing articles upon, and contains a very efficient self-acting facing arrangement, whereby the facing of the ends of the cylinder is performed simultaneously with the operation of boring. Their screwing-machine, also, is worth looking at, particularly the method of manipulating the dies, and also the piece of iron to be screwed; both are neat and convenient.

In regard to wood-working machinery, the United States does not come out in its strength; and, although they had scarcely any competitors in the Exhibition of 1851, they are upon this occasion far surpassed both by England and the continent of Europe. The only machine of this class deserving close attention is a compound circular saw, where cross-cutting or ripping can be conveniently and promptly brought to bear as required, and yet the combination is effected with great simplicity of parts.

It will thus be seen that in this limited collection of machine-tools from the United States of America there is really more to arrest the attention than in some of the more extensive displays of other foreign countries whose tools more nearly resemble our own.

England.

Although England comes far short of what might have been expected, considering her acknowledged pre-eminence, still it will be found that, even in her barrenness, there are some rare features which show an advance over 1862.

The machine tools of Whitworth and Co. and Sharp, Stewart, and Co., are of the highest order; few novelties are introduced by either, but detail after detail has been improved and refined until, at length, some of their machines are probably as near perfection as we may expect to see under the present arrangements of construction.

The 12-in. lathe by Whitworth and Co. is, to the refined critic, a marvel of goodness, and the closer the inspection is made, the more will its excellence appear. One novelty in the tools of this Exhibition is the substitution of a tempered piece of steel fixed in a holder, instead of the usual cutting tool formed upon the extremity of a bar of steel. A good specimen of this instrument is shown in this lathe; although these instruments are supposed to be new, it is really an old arrangement, and was frequently used by the mule-roller turners of fifty years ago. In other parts of the Exhibition the same description of instrument is used for planing and other machines, and will, no doubt, come rapidly into general use.

Whitworth exhibits a general assortment of machine tools, large and small, all capable of bearing a rigid inspection. On some of the details a difference of opinion may be expressed—one is, in regard to the manner of communicating the sliding motion to the planing bar of a shaping machine, the motion being given at one side and then imparted by the connecting rod to the stud upon the sliding bar nearly at the other side of the saddle. This firm also exhibit an excellent lathe for turning railway axles, specially arranged for that purpose; the axle is driven in the middle, having a shifting headstock at each end, and with the two turning saddles moved by a rocking shaft in a simple and convenient manner. The new tool-holder in the large slotting-machine is considered a very perfect arrangement, and most effectively removes the defects of the rigid holder, as well as the movable holders which have been in use hitherto. The machine for planing rifled shot is worth an attentive inspection, as indeed, are all the tools in the Whitworth Company, who, amid all their competitors, still retain their old supremacy, and this country ought to feel indebted to them for the display made at this Exhibition.

Sharp, Stewart, and Co. make a display of tools almost faultless; they contain little that is really new: indeed, some of them are 1862 in their broader features. Where such excellence has been arrived at by a house as well as by a nation, the avenues of improvement close up one after the other. It is impossible to study these machines without being satisfied with the careful attention which has been given to their details, so as to render them convenient and thoroughly serviceable.

This firm exhibit a considerable variety of machine tools, all well proportioned. Some are greatly admired. The radial drilling machine is considered about the best of its kind; the general arrangements, as a whole, are excellent, and especially the concentration of the handles for adjustment being brought to the point of operation, so that the driller can bring the drill to a point without wandering to the end of the radial arm, as is the case with many other machines of this class. Their shaping machine is well arranged in regard to the mode of giving the power from the gearing to the working point. Both this firm and the Whitworth Company must feel greatly flattered by seeing the many repetitions of their forms and arrangements adopted by other toolmakers all over the world.

Leeds is poorly represented. That great seat of industry does not seem to have realised the duty that England had expected at this time; still, some of the best things are from that quarter.

Tannett, Walker, and Co., have a small steam-hammer of very superior construction, but we would gladly have seen some of their great hammers and forge steam-cranes, instead of such a tiny representative.

Thwaites and Carbutt, of Bradford, come out better; their steam-hammer, with its wrought-iron framing, is superb, and admired by all, and is really worthy of the occasion. A model of the horizontal steam-hammer invented by Mr. Ramsbottom is shown by this firm; it is one of the leading novelties of this Exhibition, and has given rise to much discussion, but the majority are coming round to approval of the principle. During the Crimean war horizontal hammers were used in the manufacture of the wrought-iron Lancaster shells—four hammers, worked by a steam-engine, contained the form of the shell between them; the shell, in the form of a cylinder, closed at one end, had the open end placed between the hammers; a small amount of rapid simultaneous motion was communicated to them, and the red-hot cylinder was gradually pushed downwards, and thus made to assume the bottle form of the elongated shell. In these hammers of Mr. Ramsbottom steam is applied directly to each hammer in a manner that will admit of all the variations of the ordinary steam hammer, and deserves the special attention of all the engineers of iron and steel makers who are interested in this subject; instead of a hammer falling upon a stationary anvil, two hammers approach horizontally and expend their whole force on the mass between them, and the shock, which would otherwise have been given to the foundation, is absorbed by the article under operation. The principle upon which these hammers are constructed is so original, and the details are so ingeniously arranged, that it will repay the trouble necessary to understand it.

Another novelty is the steam-striker of Mr. Davis, from the Viaduct Works at Crumlin. By means of this ingenious and simple combination the ordinary form of sledge-hammer can readily be made to rise or fall to any height within certain limits, to turn round to any of a series of anvils surrounding it and in any position, and to strike out in any direction. This seems a likely tool to be developed in many different ways if it is found useful to the world in its present form.

In machine tools, Shepherd, Hill, and Co. furnish a few good examples; their lathes, especially, are very superior: the fitting of the slide-rests and other important parts is all that the most exacting could wish for. A small machine for turning nuts is noticeable. A series of instruments are brought to bear which contain within them the required form of the article; this principle has been largely developed in America, and of late years to some extent in England, but is still capable of much greater development wherever similar articles have to be produced in great numbers. In many of the drilling machines of this Exhibition, the old-fashioned flat drill is still to be found. This house exhibits the spiral drill, which is in every respect superior.

Wilson Brothers, of Glasgow, exhibit a radial drilling-machine upon a new system of arrangement, which is a relief from the usual stereotype. In this tool, the flat surface is departed from and the cylindrical adopted; the main upright cylindrical stand is set upon a convenient drilling-table, having within it another concentric cylinder adjustable in every direction; from it a cylindrical radial arm branches off, which is mounted with a very neat drilling apparatus. Although this combination is much admired by many, still a difference of opinion is freely expressed. The question arises in regard to the possibility of fitting the cylindrical surfaces as perfectly as can be done with flat surfaces, and, even if it may be done with equal soundness, can compensation for wear be equally well secured with the full retention of the original accuracy. The disposition of the metal is well proportioned, and likewise the transmission of power

is conveniently arranged, and the various appliances for holding articles under operation have been carefully thought out. As a whole, this new machine is a welcome addition; and an inspection even of its defects will suggest to many minds that this order of arrangement is capable of being developed in various ways.

The large punching and shearing machine of Mr. De Bergue is a beautiful and compact construction, which is much admired, and all the more that it is not a copy of the machines by some other makers. It is a new design, both in construction and arrangement, prepared to stand or fall upon its own merits.

The lathes and the machine and other tools exhibited by Great Britain in class 54, although limited in number, are really all first class, and worth a careful inspection; and, so far, help to make up for the deficiency in the British department. At the same time, England feels the want of the productions of many of her leading houses whose names have become household words among engineers. There is nothing from Nasmyth or Hulse; from Smith, Beacock, and Tannett, or Fairbairn. We miss Greenwood and Batley, and many others who can ill be spared in this great competition.

In machinery for working wood, England is comparatively better represented than in machinery for treatment of metal. As an industry, it is of limited extent, but most of the leading houses make some display. This branch of the trade has been mostly developed since 1851.

At the commencement of the present century, the inventions of Bentham and Brunel paved the way for almost all that has since been effected. The celebrated block machinery at Portsmouth contains the elements of production of form as derived from a permanent copy in contradistinction to dependence upon the skill of the workman; and, although the nation was slow to recognise the importance of the principle—or, at least, was backward in adopting it extensively in the various operations of building, carpentry, and cabinet-work—it is not to be inferred that nothing was done in this direction. For many years Bramah had constructed machines for planing wood on a large scale by means of knives on a revolving wheel; M'Dowall had introduced his system of planing boards by fixed knives, the four sides being finished at one operation; and, still more recently, Tannett had constructed his copying-machines, for the manufacture of carriage wheels; but still, for various reasons, the nation did not realise the great economical advantage to be derived from such apparatus, and hand labour was mostly employed in working wood long after the time when planing and other machines had been employed upon iron.

The scarcity of labour in the United States of America had, during the interval, been gradually fostering a series of extremely simple machines to assist in every kind of operation. At the Great Exhibition of 1851 a number of these simple machines were displayed. They were mostly constructed of wood, in an excellently primitive manner, according to English notions; but the ridicule which was at first excited was very quickly dispelled when they were set in operation, and soon produced a complete change in the public mind, which led to the most important results. Before 1855 several houses had entered heartily upon the work. The French invention of the band-saw of that year by M. Périn gave another impetus, likewise the importation of the gun-stock machinery for Enfield in the previous year, each tended to open up the subject; so that by the year 1862 the display of wood machinery by English houses was upon a grand scale, and the sound substantial character of their general construction, placed them far above the more flimsy American productions.

In this Exhibition, although proportionately with the extent of the industry, wood machinery of the generally useful class is moderately well represented, still it comes short of 1862. We miss the more exquisite tools of that year. The gun-stock machine for bedding the lock, from Greenwood and Batley, and other machines of analogous character, gave a high tone to the national display, which is entirely wanting on the present occasion.

Of the three English houses who make the best display, Robinson and Son, of Rochdale, is the most conspicuous. Their machines are all of the most substantial character, admirably arranged, so as to afford every facility and convenience in working, combined with great simplicity; at the same time, there is not so much novelty as might have been expected. Their chief effort is in the class of machines that are required in great numbers, and are similar in finish to those sold in their ordinary business. Of these machines, one for mortising is about perfect—so nicely balanced in its working parts, and arranged so as to put on the break of the operation of stopping in a very effective manner.

The tenoning-machine also is very perfect and complete. It is susceptible of any adjustment, and may be set to cut a long and short shoulder, or both of the same length, with equal facility. The machine for producing mouldings, with its anti-frictional spindles, would seem to fulfil all that the builder can desire; and it is extraordinary that, with such machines in existence, we should still have so much of the hand-planing system in operation. Their circular-saw bench, with its arrangement of gauges, is also well combined. The same may be said of the jigger-saw, in which the punching of holes in the saws is obviated by a method of gripper, which answers the purpose equally well; indeed, all the machines of this house have the same character of goodness and general adaptation for the purpose intended.

Another extensive exhibition of this class of machinery is by Powis, James, and Co., of London; and, judging from the admirable display here made, it is difficult to draw a line of comparison between them and the firm of Robinson and Son, they are both so very superior. One of their machines in particular is very good; it acts at one time upon the four sides of any piece of wood of any form; it is susceptible of any adjustment, and has a self-acting feed that can be graduated to any desired rate, and without any complication. To engineers who have to prepare lagging for steam-engine cylinders this machine is well adapted, and, being of good workmanship and sound construction, is likely to receive attention. A moulding-machine is equally good, and seems to have been well thought out in all the details.

As has been remarked already in regard to Robinson and Son, so here also there is little novelty, unless it is in the mode of backing the endless band-saw in a separate box, and the manner of tightening the jigger-saw by a coach-spring arrangement. Both seem good and likely to give satisfaction in ordinary working.

A third house, Charles Powis and Co., of London, also make a moderately good show. Their machines are generally of a lighter character than the other houses; some are adapted for power, others for manual labour, but all seem very handy, and may be considered good practical machines, likely to be generally useful in the smaller workshops of the country. Their universal joiner and mortising-machine, are both most useful tools, and worthy of extensive adoption.

The one great lesson taught by this Exhibition is this, that for the future we have no monopoly in machine tools, either for wood or iron; and, if we are to hold our own, it will only be by the united efforts of masters and workmen. The advantages of coal and iron, which we so abundantly enjoy, may be overrated; the means of transport are such that any difference of cost may be counterbalanced by the conditions of labour. Our workmen must be prepared to understand that foreign competition will determine the prices of machinery and the wages that can be paid to workmen, and that combinations and strikes are not only useless, but are really disadvantageous to their own interests. Besides, such disputes alarm the capitalist, and dry up the mental energy of those who have to plan and originate. The time has arrived when the most strenuous exertions will have to be made by us all in order to produce machinery of high quality at a moderate cost; to secure this we require harmony and the co-operation of all concerned. We also require greatly increased facilities for becoming acquainted with foreign scientific literature, in order to know the inventions and progress of other countries, seeing that both France and Germany are familiar with all that takes place in England.

That there is no lack of talent or invention is abundantly evidenced by our past history, but, unless we have the same advantages, especially in regard to theoretical and mathematical education, which are so abundantly enjoyed by those countries, the competition becomes so unequal that no inherent skill or ability can long withstand it. We require better education for all our leading workmen, and more especially for draughtsmen, foremen, managers, and masters, and to be given in such abundance all over the kingdom as will not make the possessor the exception, and so cause him to feel above the drudgery of his daily work. Such a general diffusion of systematic theoretical knowledge relating to the principles on which engineering and machine-making depends, will bring out the latent talent of the country. Of practical knowledge and skill there is great abundance, and when in addition the head has been trained as well as the hands, together with the inherent perseverance of our national character, we may still hope to retain our position in the world.

(To be continued.)

THE SUEZ CANAL.

The deep-water canal from Port Said, on the Mediterranean, to Suez, on the Red Sea, will be open, it is said, in its entire length for the passage of ships from ocean to ocean, at the end of the year 1869. The Fresh-water Canal, for vessels of light draught of water, is already navigable, and we find it mentioned in the report of the Company that the gross receipts for the first six months of the year amounted to £20,864; the tons carried were 9,506, and the passengers 20,132. Since July, the quantities of goods sent through the canal have trebled, and, at the present rate of progression, it is obvious that some portion of the traffic across the Isthmus will be diverted from the railway line between Alexandria and Suez, in addition to a new trade being created. The opening of the small channel will pave the way, by establishing agencies and through

water communication, for the larger shipping trade which will follow the completion of the Salt-water Canal. On the Mediterranean side—at Port Said—the Messageries Imperiales, the Fraissnet Company, and the Russian Company, have organised regular steam services, with the view of gaining a position when the grand canal is opened.

The history of the rise of Port Said is the history of all the other towns and workshops in the isthmus. An idea of the rapidity of their foundation, and the conditions of their growth, may be formed by the following description:—Having entered the port a vast parallelogram of ground appears, enclosing a surface of 36 hectares of water (about 90 acres). This great basin has four deep indentations which form secondary basins. On the west the basin of commerce, containing 4 hectares; the basin of the arsenal, 3 hectares; the basin of Four-à-Chaux, 5 hectares; and on the East the basin of the marine, 3 hectares: the total area of the port, including these basins, exceeds 51 hectares (or about 127 acres). In April, 1867, there remained to be raised 2,732,000 metres of earth, in order to excavate the port and basin of Port Said and form it to its full depth. Eight dredging machines are employed, and they each raise 1,200 metres per day, so that in ten or eleven months the work may be expected to be finished. Port Said is the first step towards the civilisation of this country. It is only a few years since M. de Lesseps and his companions made their exploring visit in the Desert, where no human being up to that time had taken up his abode, and when the land now forming the site of Port Said was covered with the waters of Lake Menzaleh. A small strip of sand, of the breadth of 200 metres, formed the outline of the sea coast, a small barrier, beaten on the one side by the waves of the Mediterranean, on the other by the waters of the lake. No tree, nor even a blade of grass, grew there sufficient to shelter the sea birds. It was here that the first stroke of the spade was given to open the cutting destined to form a passage for navigation between Europe and Asia. By the side of this cutting habitations arose, at first humble, and afterwards of a more ambitious character. By degrees the band of earth increased, and the produce of the excavation filled up the marsh, and so formed a foundation for the city. The excavated earth was employed for the embankment, and the soil by degrees rose above the water, and the lake was driven back. Wooden cottages, imported from France, were erected on it, and then followed houses in masonry, specially constructed for workshops and as residences for the *employés*; an hotel for travellers, shops nicely ornamented, a lighthouse, a chapel, and hospital succeeded. The residence of the *employés* and workmen gave rise to native speculation, fresh food was brought in from the interior, and a market was established, which, though humble at first, was most useful. Thus was founded the first village in the isthmus. Port Said has now ten thousand inhabitants. It is described as an agreeable city, half industrial and half picturesque; its situation is charming. Large numbers of fishing boats ply their trade on the lake, producing, it is said, a return of half a million francs.

Port Said is specially the centre of the workshops of the Company. Dredging machines, boats, and engines of all kinds are built and repaired there. The cargoes of the ships are received there, to be forwarded and distributed in the isthmus.

Vessels of fifty and eighty tons have been towed through the Canal, and as preference is generally given to the water carriage of goods in consequence of lower rates and facilities for transhipment, we may anticipate that cargoes in bulk will take this route. The high rates of railway charges under the tariff of the Transit Administration of the Egyptian Government forbade for a long time the forwarding of Indian produce *viâ* Suez; but when they were reduced, cotton, indigo, and a few other articles were sent from Bombay for through carriage to England. These shipments gradually assumed larger proportions. The land transport, however, through Egypt still cripples the energies of the steamship owners, who have been endeavouring to create a traffic between the East and West *viâ* Suez. When the Canal Company have perfected their stations at each end of the outlet, an extension of the traffic is certain to ensue. The steam companies whose vessels ply to and from Suez may find it economical to have their own specially constructed decked barges for the loading of coals at Port Said.

A system of towage, the invention of M. Bouquié, practised at the Canal St. Martin, Paris, has been adopted for the provisional transport of goods from one sea to the other by means of the Fresh Water Canal. The system is that known as the immersed chain, upon which the towing vessel hauls itself along, drawing in its train barges laden with thousands of tons of merchandise.

The tugs employed will be 20 metres long by 3·50 metres wide, and are each furnished with an engine of 18 horse-power. The chain by means of which the traction is effected runs over a pulley with teeth, each link of the chain fitting exactly to the tooth of the wheel, which is placed on one of the sides of the tug, an arrangement which allows the chain to be taken hold of and released with the greatest ease. This system has the advantages over the ordinary towage, of greater lightness and greater simplicity of machinery, being easier to manage in starting or stopping, or for the passing of two tugs going in opposite directions on the same chain. The conveyance of merchandise and passengers from one sea to another is now managed so as to convey 1,000 tons per day through the isthmus. The Canal Company has thus started its works.

THE PACIFIC RAILROAD.

A correspondent sends us the following interesting Table of Distances and Stations from Chicago to San Francisco.

The following Table of Distances on the Central Pacific Railroad, between New York and San Francisco will, doubtless, be considered by our readers as deserving of being recorded in our pages. It will be seen that the distance from Chicago to San Francisco is 2,340 miles. If a train should run at the rate of twenty miles per hour, including stoppages—which is, perhaps, the average rate on railroads in the United States—it would require a little less than five days to accomplish the distance. As for gradients, the traveller would ascend from the level of tide-water at New York or San Francisco, to a height of 8,242ft., or over a mile and a half, at Evan's Pass.

Name of Place.	Distance from point to point.	Total Distance.	Elevation in feet.
San Francisco	...	...	tide.
Goat Island	1½	...	tide.
Oakland	4½	6	23
San Leandro	8	14	45
Hayward's	5	19	73
Vallejo's Mills	8	27	121
Hottinger's	10	37	385
Livermore Pass	12	49	734
San Joaquin River	20	69	22
Stockton	10	79	22
Woodbridge	13	92	83
Cosumnes River	14	106	106
Sacramento	18	124	56
Arcade	7	131	76
Autelope	8	139	180
Junction	3	142	189
Rocklin	4	146	269
Pino	3	149	420
Newcastle	6	155	930
Auburn	5	160	1,385
Clipper Gap	7	167	1,785
Colfax	11	178	2,448
Good Run	10	188	3,245
Dutch Flat	3	191	3,425
Alta	2	193	3,625
Shady Run	4	197	4,125
Blue Canon	5	202	4,700
Emigrant Gap	6	208	5,300
Cisco	8	216	5,911
Crest	13	229	7,042
Truckee River	14	243	5,866
Little Truckee	8½	251½	5,860
Eagle Gap	13½	265	5,000
Hunter's	9	274	4,640
Glendale	8	282	4,430
Big Bend Truckee	29	311	4,219
Humboldt Lake	41	352	4,047
Oreana	30	382	4,160
Mill City	35	417	4,259
Big Bend Humboldt	37	454	4,392

Name of Place.	Distance from point to point.	Total Distance.	Elevation in feet.
Iron Point	19	473	4,460
Reese River	33	506	4,550
Skull Ranch	10	516	4,590
Shoshone Point	13	529	4,960
Be-o-wa-we Gate	8	537	4,735
Gravelly Ford	4	541	4,780
Twelve-Mile Canon	5	546	4,825
Two-Mile Canon	22	568	4,990
South Fork	9	577	5,052
North Fork	24	601	5,220
Bishop's Creek	19	620	5,418
Humboldt Wells	15	635	5,650
Nevada State Line	65	700	4,830
Point on Salt Lake	75	775	4,290
Bear River	45	820	4,320
Weber Canon	25	845	4,654
Echo Canon	31	876	5,355
Echo Pass	26	902	6,879
Bear River	18	920	6,045
Reed's Summit	30	950	7,567
Green River	75	1,025	6,092
Bitter Creek Summit	20	1,045	7,175
Bitter Creek	13	1,058	6,315
Bridger's Pass	97	1,155	7,534
North Platte	23	1,178	6,695
Rattlesnake Pass	54	1,232	7,560
Laramie Pass	35	1,267	7,175
Evans' Pass	30	1,297	8,242
Foot Black Hills	31	1,328	7,040
Julesburg	149	1,477	3,513
North Platte Junction	78	1,555	2,790
Brady Island	22	1,577	2,640
Willow Island	18	1,595	2,514
Plum Creek	20	1,615	......
Elm Creek	19	1,634	......
Port Kearney	21	1,655	2,128
Wood River	19	1,674	......
Grand Island	18	1,692	......
Lone Tree	22	1,714	......
Silver Creek	22	1,736	......
Columbus	18	1,754	1,458
Shell Creek	17	1,771	......
North Bend	14	1,785	......
Fremont	15	1,800	......
Elkhorn	18	1,818	......
Papillon	16	1,834	......
Omaha	12	1,845	968
Chicago	494	2,340	625
Toledo	244	2,584	585
Cleveland	113	2,697	585
Dunkirk	143	2,840	585
New York	460	3,300	tide.

THE MONT CENIS SUMMIT RAILWAY.

The line of railway which has been in the course of construction for the last eighteen months over this pass, and which follows in the main the great road of the First Napoleon, was successfully traversed on the 21st Aug. over its whole length of 48 miles by a locomotive engine. A train, composed of an engine and two carriages, left the St. Michel station at 6.30 a.m. There were present the Duke of Vallombrosa; Mr. Fell, the inventor of the system; Mr. Brogden, a director of the company; Mr. Brunlees, the engineer, and his assistant, Mr. Bell; Mr. Blake, the agent of the company; Mr. Alexander and Mr. Barnes, locomotive engineers; Signor Copello, chief engineer for the Modane section of the tunnel; Capt. Beaumont, R.E., Mr. James Brogden, Mr. Jopling, Mr. Morris, and Capt. Tyler, R.E., on the part of the British Government.

Mr. Fell's system consists of the application of a central double-headed rail placed on its side in the middle of the way, and elevated about 14in. above the ordinary rails. There are four horizontal driving wheels on the engine, under the control of the engine-driver, which can be made by pressure to grasp the central rail so as to utilise the whole power of the engine, and thus enable it to work up incredible gradients without slipping. The carriages also have four horizontal wheels underneath, which, with the central rail, form a complete safety-guard. In addition to the ordinary break there are breaks upon the central rail. It would appear, therefore, impossible for the engine or carriages to leave the rails where the central one is laid.

The morning was admirably adapted for the trip, the sun shining with great brilliancy upon the Alpine peaks and the numerous glaciers which are visible in different parts of the route. After leaving the deep valley in which St. Michel is situated, the line passes by a gradient of 1 in 30 to the Pont de la Denise, where an iron bridge spans the River Arcq near the site of that which was carried away by the inundations of last year. As the little train passed the village of Fourneau, the workmen of the Grand Tunnel of the Alps turned out *en masse*, and as at all other parts of the route, they were observed stooping down and even endangering their lives for the purpose of inspecting the unusual mechanism of the engine for working on the central rail. The first very steep gradient of 1 in 12 was seen in passing Modane, and, foreshortened to the view, appeared on the approach as if impossible to surmount; but the engine, the second constructed on this system, had already proved equal to the task on the experimental line, and clutching the central rail between its horizontal wheels, it glided quickly up, under a pressure of steam not more than 80lb. to the square inch, without apparent effort. The progress was purposely slow, because no engine or carriage had previously passed over the line, and also to give opportunity for examining the works. The damages to the road on which the line was chiefly laid were found to be substantially repaired by the French Government. The magnificent scenery around, and the waterfall near Fort Sessalion, were much admired, as the sharp curves afforded different views while passing on the edges of the deep ravines. The train entered Lanslebourg station under a triumphal arch, having accomplished 24 miles of distance, and attained an elevation of 2,100 feet above St. Michel.

From this point the zigzags of ascent commence, and the gradients over a distance of four miles were for the most part 1 in 12. Looking down from the train near the summit, as if from a balloon, four of the zigzags were visible at the same instant to a depth of 2,000 feet. The power of the engine was satisfactorily tested in this ascent, and the summit was reached under salvoes of artillery from an improvised battery and amid the cheers of French and Italians who had gathered to welcome the English on the frontier. The engine again came to a stand under a triumphal arch, at an elevation of 6,700ft. above the sea. Flags of the three nations and a silk flag specially presented by Signor Ginaoli to Mr. Fell, waved over a sumptuous breakfast, also provided by that gentleman. The hospice, the lake, and the plateau of the summit, surrounded by snow-clad peaks and glaciers, rising to an elevation of from 10,000ft. to 13,000ft. were passed, and the portion of the descent commenced from the Grand Croix. The railway here follows the old Napoleon road, which was abandoned long since for diligence traffic on account of the dangers from avalanche. Masonry-covered ways of extraordinary strength had here been specially provided for the railway.

The descent to Susa was a series of the sharpest curves and steepest gradients, on which the central rail had been continuously laid. The valley of the Dora, with Susa and the convent of San Michel, and even the Superga above Turin, visible for 30 miles in the distance, presented a magnificent panorama, as the train wound through a clear atmosphere round the mountain side. The confidence of the party on a trip which would, under ordinary circumstances, have been so dangerous, was manifested by their crowding round all parts of the engine, from which, under a feeling of the security afforded by the central rail, they thoroughly enjoyed the ever-changing scenes as they passed round the edges of various precipices. Susa was entered amid the acclamations of multitudes of spectators, and the party adjourned to dine at the Hotel de France.

Thus was completed a journey unexampled in its character both as respects the steepness of gradients, the elevation of the summit level, and the difficulty with which the curves and precipices were overcome.

BRIDGE ACROSS THE CLYDE AT GLASGOW.

Contracts are about to be taken for the removal of the present Hutchesontown bridge, and the construction of a new one.

Besides the insecurity of the bridge caused by the undermining of the foundations from the great alteration in the bed of the river, there were other reasons which rendered it desirable that a more convenient and commodious bridge should be erected. The chief of these were the narrowness of the roadway and the steepness of the bridge and approaches. The breadth of the bridge is only 34ft., and the gradient 1 in 22. The new structure will effect a great change in the locality, as the steep approaches will be entirely done away with. The spacious roadway of the bridge will be practically level, retaining only so much curvature as will give a graceful outline to the design, the gradient not being more than 1 in 70. The architectural character of the work will be entirely different from that of the other bridges which span the Clydo at Glasgow, as it will be chiefly constructed of iron. The bridge will measure 410ft. in length and 60ft. in breadth, and will comprise three spans, the centre one being 114ft., and the sides ones 108ft. wide. In order to guard against the dangerous effects of alteration in the river beds, which have been so fatal to the present structure, the piers and abutments will be founded on cast-iron cylinders, each 10ft. in diameter, going right through the alluvial bed of the stream to the hard substratum of shale covering the coal measures, a depth of about 80ft. below low water. These cylinders will be filled with hydraulic concrete forming columns of artificial stone to about 15ft. from low-water mark, after which they will be filled in with solid masonry. Above the low-water level the piers and abutments will be built of white granite, with the exception of the shaft of the central piers, which will be of red polished granite surmounted by enriched capitals. The abutments' piers will be carried up 11ft. above the roadway, forming massive rectangular towers flanking each side of the entrances to the bridge. These towers and the pedestals of the piers will be surmounted by standards of a rich design, bearing each a cluster of three globular gaslamps. Circular recesses are left in the outside elevations of the towers for the reception of large medallion busts in marble or bronze, as shall afterwards be decided, and the elevation of the towers and pedestals next the roadway will be filled in with panels of red polished granite. The towers will be ornamented by a bold cornice, and harmonize with the massive architecture of the adjacent Courthouse. The arches connecting the piers will be of wrought iron of a slightly elliptical form, so as to give a light and graceful contour, and yet to preserve the important requisites of strength and rigidity. They will be relieved with ornamental cast-iron work. A gable moulding will run round the rim of each arch, and a bold projecting cornice, supported on consoles, will extend from one end of the bridge to the other, surmounted by an ornamental parapet of open fretwork. In the spandrils will be deeply-recessed panels, filled in with floral scroll work and shields for armorial bearings. In the centre of the bridge a large panel will contain the city arms, and on the shields in the spandrils will be the arms of the Trades' House, University, Hutcheson's Hospital, Clyde Trust, and other public bodies. The ironwork will be tastefully painted and decorated in harmony with the general style, and the armorial shields, lamps, standards, and bosses of consoles, will be bronzed and relieved with gilding. The bridge is to be completed in two years. The engineers are Messrs. Bell and Miller.

THE KHIVANS.

The Khivans are a rude and uncultivated people, and in most matters of science as far behind Europeans as semi-barbarous Asiatics generally are. They have but few roads, and their bridges aro equally rare. The population is poor and scanty. There is no manufacture, and little trade. Their sole riches consist in fields, cattle, and slaves. In the art of war and its appliances, they are contemptible; their guns, of which they can boast but a poor show, are clumsy; their powder is very inferior; their balls so badly made that they have to be wrapped up in felt to fit the bore of the cannon; and their knowledge of gunnory is rudimentary in the extreme. For subsistence they depend entirely upon the grain grown upon their fields. But they inhabit a tract of country to which Nature doles out moisture with a niggard hand, and they are consequently forced to make up for the natural deficiency of water, by securing an artificial supply. Fortunately for them, the river Amu serves as a huge reservoir, and by a sort of scientific instinct, they take advantage of its waters, and conduct them by means of channels over the surface of the thirsty land.

From the dryness of the climate and the absence of rain, the ground can only be cultivated with the assistance of artificial irrigation, for which purpose several canals intersecting the whole length of the Khanat are conducted from the Amu. The breadth of their canals is from 10 to 25 fathoms at their commencement, but diminishes, as they proceed, to two or three fathoms. Many of these canals are navigable. Smaller canals branch off into the fields, and plots of arable land from the larger ones; in this manner the whole Khanat is intersected in all directions by canals of greater or smaller depth and breadth. During the overflowing of the Amu, the waters are generally higher than the surface of the fields, and are confined within the canals and ducts by earthen embankments. For the irrigation of the fields, a part of the embankments is pulled down, or else the pipes which pass through the embankment are opened. It is only in elevated parts which do not allow of this method of irrigation, that water wheels, 2ft. in diameter, with earthen and leathern buckets attached for lifting the water, are used.

This is nothing more nor less than a simple and effective system of agricultural irrigation, which would do credit to a more civilised nation. The result is that the crops are good and regular, and the Khivans are able, out of their own superabundance, to sell grain to the neighbouring pastoral tribes. Surely irrigation cannot be so abstruse a science, when these poor Khivans are able to master its principles. Their work is probably rough, but it seems to be effective. There are not grand piles of brickwork or stone masonry, but simply channels and earthen embankments; and the pressure of water upon the sides during a flood is relieved by side pipes communicating with the neighbouring fields. And yet the work is on a large scale. Several canals intersecting the whole length of the Kanat, a distance of 300 versts, bespeak a great expenditure of labour. The Khivans have, in fact, without any advantages of professional engineering knowledge, hit upon the most effective general system of agricultural irrigation that the ablest engineers could design. They have, first, large feeding canals, supplied with water from an inexhaustible source, and then a network of subordinate ducts to carry this water to the nooks and crannies of the land.

The men of Khiva are certainly wise in their generation, and scarcely show to disadvantage beside us, the foremost among scientific nations. It is indeed a matter for speculation whether our scientific pride has not made us in some measure overlook the simple expedients that necessity and common sense here suggested to comparative savages. We devote our energies to some grand scheme of irrigation, with costly works and tremendous obstacles. Success is achieved at a fearful outlay, but then we have a lasting monument of our prowess, and our pride is flattered by the contemplation of it. We forget that the same expenditure, devoted to a work of a simpler and more homely, though perhaps less dazzling, nature, might have produced a result ten times more beneficial. It might almost be thought that we are occasionally blind to the fact, that the real grandeur of a work consists in the good that it is the means of doing; not in the magnificence of the structure, or the severity of the task that has been accomplished. It would be much better for India if those charged with the duty of providing for the agricultural wants of the country, would show that they never lost sight of this. India, as is well known, needs what the Khanat of Khiva is said to possess, a general system of field irrigation, fed by canals, which draw their waters from the never-failing stores of the great rivers. In districts where it would be difficult to cut those large canals, or when the tract requiring irrigation lies at a great distance from the rivers, tanks, and reservoirs would serve the purpose.

We have over and over again advocated the inaugurating of a wide-spread system of district irrigation, on a simple plan easily carried out, without any great effort or engineering skill—digging a duct from a tank to a field does not appear to call for much professional talent. Though not to so great an extent as Khiva, India suffers from want of moisture. With more water it would be transformed into a large garden. Water has been supplied to Khiva by a simple process, dictated, one would think, by Nature itself; and by the same simple process water might be supplied to a large part of India. The money which one expensive work of magnificent and costly proportions would absorb, would, if expended upon village irrigation, change the face of a province. The question as to how the large sums that are in future to be devoted to public works will be best spent, is an important and difficult one. It is easy enough to spend money upon public works; to spend it well is a different matter. Large works like the one cut across the Godavery may be desirable in many other localities, and may hold out fair prospect of profit. At the proper season they may well claim our attention and energy. But before fresh undertakings of large proportions are entered upon, the pressing wants of the country should be satisfied. Projects which will further the commercial interests of a particular locality should be shelved until projects that affect the vital interests of a population have been executed. Matters of life and death should take precedence of commercial speculations, or even of those purely agricultural speculations whose success would imply the prosperity only of the few, and the question of village irrigation is one of life and death to the masses. If the hundreds of tanks which are now in a state of decay are allowed to become gradually obliterated from the landscape, if no effort is made to put them into working condition, the population of the districts where these monuments of neglect exist, will always be liable to suffer from the caprices of climate, and dearths will occasionally supervene. With the bitter experience of the Orissa scourge before us, we ought to thoroughly realise the fact, that it is our first duty to render every part of the country as safe as human efforts can make it, against the periodical recurrence of famines. By repairing every tank

that has fallen, through neglect, into disuse, we should be arming ourselves with a really strong weapon against the inroads of the enemy. There should not be such a thing as an unused tank in India, and yet it is notorious that they are to be counted by hundreds. There is plenty of work to be done in the way of these simple repairs. The good that would accrue to the country from it is too apparent to require demonstration, and it would be effected so easily at so small an outlay compared with the value of the results. It is not as if we had to commence the work from the very beginning, it is half done for us already. The tanks exist, and only require putting into serviceable condition. Next to the repair of the old system of village tanks, we should have to address ourselves to the formation of new reservoirs at suitable points for storing up water, which now runs to waste. It is to be earnestly hoped that these *pressing* necessities of the country will receive the consideration that is due to them at the hands of the Government. We are bound to begin with those works which shall secure the population from famine and other agricultural distress. We want to feel certain that the crops upon which the lives of thousands depend, are not entirely at the mercy of a capricious rainfall. Science, backed by money, can do this, and do it easily. When this is accomplished there will be time to think of more showy undertakings. Agriculture in India is not less dependent upon science than in other quarters of the globe, notwithstanding the generosity of a soil warmed by a Tropical sun, and agriculture is a sphere that science need not be ashamed of.

Pater ipse, colendi
Haud facilem esse viam voluit, primusque *per artem*,
Movit agros.

Virgil's lines are not inapplicable to the case in point; at all events, agriculture in India has great obstacles to surmount, and science alone can develop the resources of the ground.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—SECTION G.

ON THE USE OF MOVEABLE SEATS FOR SLIDE-VALVES.

By JAMES R. NAPIER, F.R.S., Marine Engineer, and W. J. MACQUORN RANKINE, C.E., LL.D., F.R.S.

(*Abstract.*)

The great practical convenience of the slide-valve and link-motion, as means of varying the rate of expansion in steam-engines, is well known. An objection to their use, however, arises from the fact that the points of admission, cut-off, release, and compression are related to each other in such a manner that, in designing a slide-valve motion, the fixing of any three of those points for a given position of the link fixes the fourth point also. For example, suppose that in a certain position of the link, the positions of the eccentrics and the lap or cover at the induction-edge of the cylinder-port are so adjusted as to give a certain rate of expansion, then the only element remaining capable of adjustment is the cover at the eduction-edge of the port, and that element, when it is fixed, fixes at once the release and the compression; and it often happens that the best positions of the points of release and of compression are inconsistent with each other, so that a compromise has to be made. That objection, in some examples of slide-valve motion, has been overcome by the use of double slides; but in all the double slide-valve motions hitherto introduced there exists the defect of complexity in construction and working, for, in addition to the ordinary handle of the link-motion, a second handle has to be used in varying the rate of expansion. The authors of this paper propose to accomplish the same result in a very simple way—by giving a small sliding motion to that part of the valve-seat which contains the induction-edges of the cylinder-ports, so as alternately to contract and enlarge those ports at each stroke of the engine. The only mechanism required in addition to the ordinary slide-valve gear consists in the moveable seat, with a rod and a third eccentric to give it motion. The rate of expansion is varied when required by shifting the link in the ordinary way by the use of the ordinary handle alone; yet the effect is the same as if the admission and the exhaust of the steam were regulated by two different slide-valves, each with its own link-motion and pair of eccentrics. Hence, in designing the valve-motion, the points of release and compression can be adjusted to the best positions independently of the points of admission and cut-off. The authors consider that the moveable seat which they propose, ought to be used together with a kind of slide-valve in which the pressure of the steam is balanced, such as that introduced by Mr. Thomas Adams, in order that the different rates of travel of the slide-valve over the fixed and moveable parts of the valve-seat may not produce unequal wear.

REPORT ON THE CONDENSATION AND ANALYSIS OF TABLES OF STEAMSHIP PERFORMANCE, AS PUBLISHED IN THE YEARS 1857, 1858, 1859, 1860, 1861, AND 1862.

By JOHN SCOTT RUSSELL, C.E., F.R.S.; WILLIAM FAIRBAIRN, C.E., LL.D., F.R.S.; THOMAS HAWKSLEY, C.E., F.G.S.; JAMES R. NAPIER, Marine Engineer, F.R.S.; and W. J. MACQUORN RANKINE, C.E., LL.D., F.R.S.

(*Abstract.*)

The British Association possesses a large collection of records of the performance of steamships, accumulated in the course of many years, and printed in the reports of previous meetings, but in a form so bulky and cumbrous as seriously to interfere with their utility for practical and scientific purposes. At the Nottingham meeting in 1866 it was resolved to entrust the committee whose names are given above with the duty of condensing and re-arranging the data contained in those records, in order to bring them into a more compact and useful shape. That has been done in the present report, according to a method of which the leading principles may be summed up as follows:—All results belonging to any special theory, and all quantities calculated by inference, or ascertained otherwise than by direct measurement, are excluded from the condensed tables; vessels for which certain essential data are wanting, are excluded (the essential data being such as the principal dimensions, the displacement the kind of propeller, the speed, the indicated horse-power, &c.); the vessels inserted in the condensed tables are divided into groups according to their full speed, and very numerous groups are subdivided according to the displacement; an uniform arrangement of the data is adhered to as far as practicable, and the tables are drawn up in such a form as to be printed in octavo pages.

ROYAL GEOGRAPHICAL SOCIETY.

THE PRESIDENT'S ADDRESS.

(*Continued from page* 212.)

The great distinction between the views taken by Sir Henry Rawlinson and myself is, that whilst I believe the main outlines of the Aralo-Caspian region were determined by movements of the earth in quaternary or later tertiary times, he refers the great changes which he believes to have been made in the courses of the Oxus and Jaxartes to no very distant historical dates; thus referring the emptying and refilling of the deep hollow in which the Aral Sea lies to comparatively modern times.

He offers, indeed, one argument, which, if sustained, would at once dispose of my view. In support of the opinion that the Aral Sea was non-existent in the thirteenth and fourteenth centuries, he states that in those days travellers from Europe to Asia passed over dry lands since occupied by that sea. If this were substantiated, the belief I have adopted that the separation of the Aral from the Caspian, and the upheaval of the broad intervening plateau of the Ust-Urt, would be at once removed from a pre-historic period to the days of Henry III. and the two first Edwards of English history.

Now, surely, if so great a terrestrial change of surface as this had happened in the thirteenth or fourteenth centuries, the rumour of it would have been bruited throughout Europe and Asia. Unwilling, however, to rest upon any notions of my own, I have consulted that admirable comparative geographer, Colonel Yule, as to the routes taken by the mediæval travellers of that date; and he having favoured me with much information respecting the whole of this subject, I extract from his letter the appended long note.* By reference to it the reader will see that no foundation for such an assertion is to be traced in the narratives of these old travellers. For (even when the starting point of their journey eastward lay upon the Volga, their line of march is traced either quite

* After alluding to the little weight to be attached to the statements of the Greeks, tracing the imperfect accounts of Herodotus and his followers, and rejecting the Oxiana Palus of Ptolemy, which had been made "to do duty," as he says, for the Aral on many respectable maps, Colonel Yule proceeds to say:—

"We are on surer ground in the narrative of the Embassy of Zemarchus to the Khan of

to the south of the Aral through the lands of modern Khiva, or more to the north of that sea, and probably beyond sight even of its shores.

In considering what changes have or may have occurred within the historic period, and quite independent of all former or geological changes, I necessarily attach great weight to the opinion I have recently obtained through my friend General Helmersen from M. P. Semenof, the President of the Physico-Geographical section of the Russian Geographical Society, who has distinguished himself by his researches in the Thian Shan chain of Central Asia. Whilst he rejects, like myself, the hypothesis of the great Aral depression having been emptied and refilled in the historical period, he refers the desiccation of the Asiatic rivers and the diminution of lakes to the decrease of glaciers in the high mountains, as well as to great evaporation. By these causes he thinks that at one period the Aral Sea may have been diminished, though he is firmly of opinion that such a deep depression could not have been emptied and refilled. In reference, however, to the former Caspian branch of the Oxus, in the existence of which he believes, he supposes that many streams, now dry or nearly so, formerly augmented the volume of the Oxus, thus enabling it to supply a branch to the Caspian by the Gulf of Karabogas, and that to the failure of this supply we may attribute the drying up of the branch, without involving any great physical change of outline of the land. In this case the Aral Sea, occupying a separate cavity not communicating with the larger depression, would, as he thinks, become shallower, and to a great extent obscured by reeds, so as to have remained unknown to travellersfor 500 years before, and 500 years after Christ. M. Semenof suggests that in those days when the south-western branch of the Oxus existed, travellers proceeding northwards and meeting with little but reeds and marshes, might very well suppose that the Aral was merely an extension of the great Bay of Karabogas of the Caspian Sea. In illustration of this view he informs me that the inhabitants around the lakes Ala Kul and Sassyk-Kul have at this day no precise conception of their separation, and term them both Ala Kul simply, because they are unacquainted with the marshy and inaccessible isthmus between them. In Central Asia, too, the River Tchu, through its desiccation, has lost its former communication with the Lake Issyk-Kul, just as in the Aralo-Caspian region the Sary-su River has failed to reach the Syr Daria; and this last river, having lost its northern affluents, could no longer contribute (if ever it did) by any of its branches to the Oxus, and has found an easier embouchure in the Aral. How easily these changes of direction are effected in the course of rivers in flat and sandy countries, is well known to many Russian geographers who have explored Central Asia.

Thus, the Oxus, deprived of many of its former affluents, ceased to be able to throw any portion of its waters into the Caspian, and took the straight course into the Aral. This natural operation, as Semenof observes, may have also been accomplished within the historical period, and so, since its south-western or

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the Turks about the year 570. The remains of the historian Menander, which relate this mission, are unfortunately, but fragments, and do not say how Zemarchus got from Byzantium to Central Asia. But on his return route, which lay to the north of the Caspian, we are told that before reaching the rivers Ich and Daich (apparently the modern Emba and Ural)* he passed for twelve days along the sandy margin of a certain *great and wide lagoon*. This looks very like the Aral; nor probably will Sir Henry Rawlinson deny its existence at that date. But I quote the allusion to show that even the Greeks, once they got actually to the site of the Aral, did recognise its existence.

"We now get to a period regarding which there is no controversy. A long *catena* of geographical works, as Sir Henry Rawlinson tells us, represents the two great rivers as falling into the Sea of Khwarezm, *i.e.*, the Aral. But is it the case that this chain of testimonies ceases with the year 1300? Among those quoted by Humboldt even are some of later date, such as Abulfeda and the Persian Hamdallah. It is the case, no doubt, that those Eastern geographers often copy what has been said by their predecessors centuries before; but a passage which Humboldt quotes from Hamdalla, a writer of the 14th century, appears to be original. It speaks of the Sea of Khwarezm (or Aral) as having a compass of 100 parasangs, and separated from the Caspian by a tract of 100 parasangs in width. It contains also the remarkable statement that only a *part* of the water of the Oxus then flowed into the said sea, which was fed also by the River of Ferghana (the Jaxartes) and others.

"Two centuries later, when the first English traveller† reaches those regions, he finds the Aral in existence, though his account of it is but hazy; and when Russian geography springs up at the end of the 16th century, we find that it already knows the Aral well as the Blue Sea.‡

"Knowing then, as we do, how many indications point to the existence in those regions in recent geological times of a great inland sea, and finding a tolerable chain of evidence as to the Aral itself—either positive or implicit—down to the days of modern geography, I feel it difficult to believe, on the authority of the Persian MS., that this great sea, nearly 600 miles in circuit, with precipitous sides and attaining a depth of 37 fathoms, did, for a number of years, entirely cease to exist, and then again became as we see it and as old Arab geographers had described it. I by no means desire to dispute that there may have been a material contraction of its area at the time when a considerable part, if not the main stream, of the Oxus flowed into the Caspian; but this is a different thing from its entire disappearance and desiccation.

"There is one argument on this subject urged by Sir Henry Rawlinson which I think a review of the facts in detail will scarcely bear out. He refers to that period during the 13th and 14th centuries when the vast extent of the Mongol dominion threw open Asia, which for a succession of years was penetrated by envoys, missionaries, and adventurers, several of whose narratives have come down to us, and when a regular course of trade was established, regarding which we have many particulars.§ The route usually followed by those travellers, Sir Henry says, lay exactly across the site of the Sea of Aral; yet not one of them mentions it. If this were so indeed, it would be vain to maintain the *improbability* of what would he so easily established as a fact.

"But let us glance at the routes followed by these travellers successively from the first of them in the middle of the 13th century. This was Friar John of Plano Carpini, sent on a mission from the Pope to the Great Khan in 1245-47. Friar John, though he writes in the main like a man of sense and reading, is not a good geographer. He makes the Dnieper, the Don, the Wolga, and the Jaic all fall into the *Great Sea*, the '*Mare Magnum*, which has its issue by St. George's Channel at Constantinople;' and rides for many days along the shores of the Caspian, apparently under the impression that it is but a part of the Euxine.‖ We might ask, in passing, if there were no Friar Johns among the ancients capable of the more venial error of confounding the Sea of Aral with the Caspian? Be this as it may, there is no reason for carrying the route of Carpini's party over the bed of the Aral. After crossing the Jaic, it lay for many days through the land of the *Cangitæ*, or Kankhlis, in which they found few people, but very many and large salt-marshes and lagoons, which they took to be the *Paludes Mæotides* of the ancients, and which probably were those which still exist to the north and north-east of the Aral.¶ They then enter the land of the *Bisermini*, or Mussulmans, and come upon the cities and cultivated lands of northern Turkestan.

"Friar William de Rubruquis, eight years later, is more correct in his notions of geography. He clearly discriminates the Caspian from the Euxine, and gives a fair account of it. He gives also the general orientation of his route, running due east from the Wolga for forty-five days, and then turning southward, and so continuing for eight days till he reached *Kenchak*, a city known to have been in the valley of the river Talas.

* Perhaps, however, the Ural and Ik, so carrying the route north of Orenburg."

† Jenkinson.

‡ "See in Levchine's 'Description des Hordes et des Steppes des Khirghiz Kazaks,' in his dissertation on the Jaxartes, p. 462, a quotation from a Russian geographical work of the time named."

§ "Surely there is a *lapsus*, when Sir Henry Rawlinson speaks of these merchants as returning with the tea and silk of China; or, if he has grounds for including the former, it would be most interesting that they should be produced. In 'Cathay,' I have indicated the mention of tea by Ramusio's Persian friend Hajji Mahomed, as the first known to me in any European book.

‖ "See in D'Avezac's edition, p. 743."

¶ "See the narrative of Carpini's companion, Benedict the Pole, in D'Avezac, p. 777."

If you protract this route as well as the data will admit, you will find that it entirely clears the Aral.*

"Another traveller, who visited the Court of Mongolia in the same year with Rubruquis, was King Hethum or Hayton, of Little Armenia. He, too, after visiting Batu Khan upon the Wolga, rides eastward across the Jaic; but, as he passes the Irtish Channel also, his route must have lain far to the north of the Aral. On his return he passed by Samarkand and Bokhara into Persia.

"Marco Polo himself never mentions the Aral, indeed; but neither does he mention the Jaxartes, and seems never to have been nearer either than at Kashgar. In the preliminary chapters of his book, in which he speaks of the journey made by his father and uncle from the Wolga to Bokhara, be unfortunately gives no particulars of their route,† excepting that they went south from Bolghar to Ukak (near Saratov) before striking east.‡

"Probably, however, it was the same as that laid down in the next century from the information of the merchants who had travelled it, by the Florentine factor Balducci Pegolotti, about 1330-1340. This route, followed by mercantile travellers bound for China, ran from Sarai, on the Wolga, to Saracanco, or Saraichik, on the Jaic, and thence in camel-waggons to Urghanj, the capital of Khwarezm, which stood on a branch of the Oxus, about sixty miles south of the present embouchure of that river in the Aral Sea. From Urghanj the travellers were in the habit of proceeding to Otrar, a few miles north of the Jaxartes, and not far from the modern town of Turkestan, and so forward to Almalik, near the Ili, the capital of the Khanate of Chagatai. Thus they travelled distinctly *round* and not across the bed of the Aral. We are told, indeed, that if they had no merchandise to dispose of at Urghanj, they might save from five to ten days by going direct from Saraichik to Otrar. If we lay down this direct route with geometrical and literal directness, it will indeed pass through the extreme north of the Sea of Aral. But even direct railway lines are not so straight as that; and there can be little doubt that Pegolotti's direct line was much the same as that followed by Carpini and Rubruquis in the preceding century.

"The same route that Pegolotti recommends, viz., that from Sarai to Saraichik, and thence to Urghanj and Almalik, was followed by Friar Pascal, of Vittoria, in 1337,§ and (as far as Urghanj) by Ibn Batuta, a few years earlier, in travelling from Sarai to Bokhara.

"It was probably also the route followed by John de' Marignolli, on his journey towards Peking, in 1339-42; but, unfortunately, he says nothing whatever of his route between the two Mongol capitals of Sarai and Almalik.

"We have named all the travellers, as far as I am aware, that have left any record of their journeys in those regions during the period to which Sir Henry referred. None of them, we must acknowledge, say anything of the Aral Sea; but we see also that it cannot be maintained that they gave the practical disproof of its existence which would be afforded by their travelling dryshod across its bed! and the travellers' narratives were the bases of the maps to which Sir Henry has referred. The Catalan map does not, indeed, contain the Sea of Aral; but neither does it contain any hint of the Jaxartes. The great map of Fra Mauro, though it contains no Aral, represents the river Amu (or Oxus) as flowing into the Lake Issik-kul, which is, perhaps, an adumbration of some knowledge of its discharge into another sea than the Caspian. The traditions of geographers are hard to correct. I do not know what map first shows the Aral under anything like its proper conditions. Many years after the date of the Russian geography to which we have alluded as so clearly indicating the Aral under the name of the Blue Sea, we find John Blaen, in his great atlas (1663), representing the Jaxartes as flowing into the Caspian, and a duplicate of the same river, under the name of *Sur*, flowing by Tashkend into the 'Lake of Cathay,' with a difference of 30° of longitude between the two! Even Petis de la Croix, in the maps (sometimes singularly happy) which illustrate his translation of the History of Timur, has no indication of the Aral.

"There is, indeed, one mediæval map, which at first sight seems to bear strong testimony to the existence of the Aral Sea in the beginning of the 14th century. I mean that curious one executed by the old Venetian Marino Sanudo, and submitted by him to the Pope and King of France, about 1325, with his grand scheme for the destruction of the Mohammedan power. This map exhibits very clearly a *Mare Yrcanum, Cazpis*, or *de Sara*, in the proper position of the Caspian. It is connected by a river with another sea, further east, marked *Mare Caspium*, and full of islands, which is in a startling degree suggestive of the Aral. Further still to the east, towards *Sera*, appears a third and a smaller sea, without a name, into which the *Gyon* flows (*i.e.*, Jihun or Oxus). I dare not, however, lay much stress on this map, which contains nothing else to corroborate a claim to exacter information. The multiplied seas *may* have sprung only out of some misunderstanding of the classical geographers." ‖

* "For a detailed examination of Friar William's route see 'Cathay and the Way Thither,' p. ccxi. *seq.*"

† "The *Tigeri*, or Tigris River, which Polo mentions as crossed by the party, was supposed by Marsden and his successors to be the Jaxartes; but Pauthier has clearly shown it to be the Wolga. (See his 'Polo,' p. 8; also 'Cathay,' p. 234.)"

‡ "Timur, invading Kipchak and Russia, went so far north as to cross the Tobol before crossing the Jaic."

§ "'Cathay,' p. 232."

‖ "The map is engraved in 'Bougarsius, Gesta Dei per Francos,' vol. ii. There is a *quasi* fac-simile of it in the second volume of Vincent; but in this latter the third sea is scarcely to be recognised."

Caspian branch dried up, the Oxus, by throwing all, instead of a part, of its waters into the Aral, has given to that sea a better marked place in human knowledge than it had in the fourteenth and fifteenth centuries.

Before I quit the subject of the now desiccated former branch of the Oxus, I may state, on the authority of my correspondent, General Helmersen, that recently a memoir was presented to the Imperial Geographical Society of St. Petersburg, suggesting that men of science should be sent to the spot to examine into the evidences of that ancient bed of the river, and also to test by soundings along the shore of the Caspian if any remains of the old delta of that stream could be detected. But the project, as well as the continuation of the survey and soundings of the southern edges of the Caspian, have both been suspended, I believe from motives of economy. The latter important work was under the able direction of Captains Ivanchnizow and Oulsky, who had already proceeded so far that in less than three years they would have completed the survey of the whole of that vast interior sea; and it is indeed much to be regretted that a work of such great geographical interest should have been thus set aside.

In conclusion, my belief is:—1. That the Caspian and Aral have existed as separate seas before and during all the historic period. 2. That the main course of the rivers Jaxartes and Oxus, as also of the sites of the Caspian and Aral seas, were determined in a pre-historic period. 3. That at one time the Oxus emptied itself both into the Caspian and the Aral, and that the Caspian branch stream was sent back to the course of the other portion of the stream, either by the local rise of some lands between Khiva and the Caspian, or by desiccation and a want of sufficient power of water. And, lastly, that the Jaxartes never was deflected from its natural east to west course, to pass southwards, and so reach the Caspian by the southern end of the great elevation of the Ust-Urt, after a very long course at right angles to its present direction, to say nothing of its having in that case necessarily united with the Oxus by the way—a fact, of which, as already stated, all history is silent.

If old authors believed, without personal observation, that the Jaxartes, as well as the Oxus, fell independently into what they called the Caspian, we may easily account for such a notion, at a time when the true meridian of barbarous places lying to the north of any line of intercourse between Greece or Rome and Asia was wholly undetermined. May we not rationally infer that the ancient geographers believed that the Jaxartes, as well as the Oxus, flowed into the Caspian, simply, as suggested by Rennell, from having heard that the Jaxartes terminated in one great sea, and that they naturally believed that the Aral was then simply the north-eastern portion of those large inland waters of which they had heard, but of which they knew nothing accurately?

In truth, when we know that the geography of the Greeks, and even of the Romans, was worthless, in regard to any lands beyond the parallel of the mouth of the Oxus, we necessarily recur to the works of the earliest Arabian geographers, in which the Sea of Khwarezm was first exhibited as a separate sea. As such it also appears in the maps of Rennell, of Williams, of Yule, and, in short, of all the best authorities, representing that which I believe to have been the true physical condition of the region during all historical time, and which I maintain dated from an ante-historical period.

In estimating the present or future relative importance of the Oxus and Jaxartes as lines of commercial traffic with China and India, I have no hesitation in saying that the latter river holds the first place. By reference to the memoir of Lieutenant Wood, in the tenth volume of our "Journal," describing the sources of the Oxus, and still better by inspecting the map of the Bolor Mountains and Upper Sources of the Oxus, which has just appeared in our present volume (vol. 36), I agree with the able Russian geographer Veniukof, who, after alluding to the wild barbarian races which occupy the high tableland of Pamir and the adjacent mountains, adds this significant passage: "When we moreover remember that this basin of the sources of the Oxus is closed in on the north, east, and south by mountains from 15,000 to 18,000 feet high, and across which the roads for pack-animals are few and difficult to traverse, we must arrive at the conclusion that all idea of converting this region into a rich entrepôt for a trade with India and China must be abandoned." *

Before I quit the subject of the investigation of Central Asia, let me ask those of my countrymen who read German with facility to peruse the great work of Ritter, the "Erdkunde von Asien," and they will at once learn how to value the vast amount of modern discovery which is due to our Russian cotemporaries.

On former occasions I have naturally adverted to several of these remarkable researches, but I regret that, in my last two addresses, I have omitted to notice, as I now do with special approbation, the memoir of M. Semenof, published in our thirty-fifth volume, on "Djungaria and the Celestial Mountains." As the only man of modern times who has explored a considerable portion of the Thian-Shan or Celestial Range, M. Semenof must be placed among the most distinguished of the famous band of Russian explorers—not simply for having determined many geographical positions, the forms of the land and their altitudes, but also for his careful examination of the mineral character of the rocks which constitute the loftiest masses of those regions. In so doing he has set aside one of the few errors which the illustrious Humboldt fell into, in his grand generalisations, when he was led to believe that the Thian-Shan—the great axial range of Central Asia—must be essentially one of volcanic eruption.

Influenced, doubtless, by his successful description of the Andes of South America, and the rise to their summits of active volcanoes, the great traveller was very naturally disposed to apply the same inference to the lofty chains of Central Asia: the more so as all the imperfect data he could collect seemed to indicate the existence of rocks of that class.

But as soon as the Thian-Shan was examined by the only man of science in our age who has visited it, he found nothing but sedimentary strata; and as this important rectification is due to M. Semenof alone, we must not only accord to him all due praise as a geographer, but it is specially my duty as a geologist to thank him for making this great observation.

In fact, the grand movements of upheaval, which determined the form of many of the loftiest mountains, whether in Central Asia or in the great northern barrier of India, the Himalayas, were caused by former expansions from the interior, doubtless due to central heat, which raised up sea-bottoms, often altering them into crystallised rocks, and elevating them to enormous altitudes, without exhibiting any true igneous rocks.

Having already twice alluded to the recent discoveries in Asia by the Russians, and having endeavoured to do honour to them by the award of our Founder's Medal to one of the most distinguished Russian explorers, it is now my pleasing duty to advert to others of their recent labours in that quarter of the globe.

On former occasions I have dwelt upon the explorations of Eastern Siberia and the affluents of the grand River Amur and the mountains to the north. Let us now turn to Central Asia proper, and see what good documents have been furnished by the different men of science who have explored those regions. I gather from the bulletins of the Imperial Geographical Society that the communications of MM. Semenof, Severtzof, Poltarazky, Abramof, Bakkof, Golonbef, and Printz, explain the physical conformation of tracts and the natural riches of regions never before reached in modern times.

Of most of these hitherto unknown and wild tracts the Russian explorers have prepared or are preparing maps. To facilitate journeys from Siberia to Pekin, Dr. Brettschneider, the physician to the Russian mission in China, has laid down upon a map all the different known roads across Mongolia, of which that which is called the post road is 1,760 versts long, between Kiachta and Pekin, with 68 relays. If the telegraph, which one of our countrymen, Mr. Gordon, who had travelled across this desert, sought to realise, be established, the journey across the desert of Gobi will soon be thought nothing of.

As to Bokhara, of which Englishmen have only painful recollections, on account of the murder of our distinguished officers, Conolly and Stoddart, we now know that two Russians, MM. Glonkovsky and Tatarinoff, who were for seven months captives there, have added much knowledge to that acquired by their accomplished countrymen Khanikoff and Lehmann in 1842.

Those of our associates who may now visit St. Petersburg may see pictorial views of Khodjend, Tashkend, and all the places taken from the Kokandians in the recent advance of the Russians along the Syr Daria, and now forming parts of the great new province of Turkestan. I learn, also, in reference to this region, so recently opened out to the civilised world, that M. Struve, the son of the great Russian astronomer, has prepared a map of the whole province of Turkestan, on a scale of 40 versts to the inch.

Deeply interested as we must all be in this grand opening out to geographers of a vast unknown country, my first request to my eminent friend, Admiral Count Lutke, must be, that as president of the Imperial Geographical Society, and also of the Imperial Academy, he will procure for our Society copies of the maps which, to their great credit, the Russian geographers have prepared.

Northern Frontiers of British India.—At our last anniversary it was my duty to dwell upon the great accession to geographical knowledge obtained by the survey of the survey of Captain Montgomerie in the mountainous region north of Cashmir and the Himalayas Proper. I have now to remind you of the highly interesting journey made by Mr. W. H. Johnson, from Leh, in Ladakh, to Ilchi, in Chinese Turkestan, a city which had not been reached in this century by any European since the days of Marco Polo and the mediæval travellers, except by Adolf Schlagintweit, who was killed. This town lies further northward than any point reached by his brothers when they traversed the Kuen Lun.

The clear and eloquent manner in which this great feat on the part of an Indian engineer, brought up under Sir Andrew Waugh, was laid before the Society by Sir Henry Rawlinson, renders all comment on my part superfluous. For he not only delineated the achievement of that traveller, but put you completely into possession of all the historical data relating to this vast and little-known region, the routes used in old times for traffic, and pointed out to you how it happened that Ilchi, once a great mart on the highway between Russia and China, had been left aside on account of the more favourable route by Yarkand. Although I have always discouraged discussions on the political interests of our own country in reference to those of our own country in reference to those of other nations, I entirely agree with the observation which fell from Sir Henry Rawlinson, that both the Russians and ourselves might trade advantageously with that great intermediate region, and that at the chief cities of each consuls of either nation might live together in perfect amity.

When that state of things shall have arrived, our geographers would no longer be wanderers, stealthily seeking to acquire knowledge, but would be associated with Russian topographers in defining the physical features of wide tracts, which, though useful to both countries for trade, are far too vast to be objects of settlement for either.

The mineral products of this region are, no doubt, as numerous and important as Sir Henry Rawlinson described them to be, particularly in gold and jade, and the opening up of a fresh trade might be highly beneficial to ourselves and to Russia, now that the Chinese domination has been entirely set aside.

Tibet.—The survey of Lake Pangkong in Tibet, by that intelligent and active explorer, Captain Godwin Austen, is another fact of marked interest in the delineation of tracts lying to the north of the frontiers of British India. Passing from Leh over the Chang La Pass, 17,470ft. above the sea, this traveller, like Dr. Thomson in other adjacent tracts, encountered the most enormous accumulation of debris which had been swept down from the Snowy Mountains, occasionally barring up the streams. He followed the great lake to within a short distance of Noh, a Tibetan town of the province of Rudok. Although the Lake Pangkong has now an altitude of 13,931ft. above the sea-level, Captain Austen showed, judging from traces of remains of shells at considerable altitudes, that its waters must once have stood at a much higher level.

* "Journal of the Royal Geographical Society," vol. xxxvi. p. 263.

At that remote period the waters were fresh and the country covered with rich vegetation; but now the waters of the lake are much too salt to nourish any molluscous animals, and its banks are entirely destitute of vegetation.

Site for a New Indian Capital.—At one of our evening meetings in January a valuable paper by the Hon. George Campbell, a judge of the newly-instituted Supreme Court of Judicature for the Bengal Provinces, was read and discussed. The subject was an inquiry into the most suitable site for a new capital for our Indian empire, there being a pretty general agreement in the condemnation of the present metropolis. Had it been possible to foresee the present extent of our dominion, it is almost certain that Calcutta would not have been our choice. It is situated at a corner of our dominion, all the most valuable portions of it lying north, south, and west of it, sometimes at distances of 1,000 or 1,500 miles. It lies in the delta of a great river, almost on the Tropic. The result of this locality is that the climate is unsuited to the constitutions of the denizens of a cold and temperate region, one-third part of the year only being congenial, while the remainder is divided between great heat and drought, and great heat and moisture. In such a climate Europeans cannot labour out of doors without imminent peril to health, and the consequence is that most Englishmen that can do so, from the Governor-General downwards, abandon Calcutta, if they can, for two-thirds of the year. Still, as the port of the mighty Ganges, Calcutta is truly a metropolis. Although at first a village, it was the seat of our commercial factory; and Bengal, to which it belongs, was our first profitable acquisition—that acquisition, indeed, which, in the sequel, enabled us to make and maintain future territories.

The desirable points to be held in view in the selection of a second capital for India are, that the locality should be central, that the climate should be so temperate that the ruling class should be able to labour effectively without detriment to health, and that the locality should be secure from the dangers of foreign and domestic aggression. There are, no doubt, other qualities which it would be convenient to combine with these, but which are probably nowhere attainable. It would, for example, be desirable that the capital should be situated in a fertile and productive territory, capable of sustaining a large population, but such a position could only be found in the low and hot valleys of the great rivers. It would perhaps be desirable that the seat of government should, at the same time, be a great commercial emporium; but this advantage cannot be combined with the more indispensable requisite of a temperate climate, since all the possible commercial emporia of India are tropical, and on the sea level. It would be desirable that the Government of India should have the benefit of a public opinion at its seat; but this does not seem to be indispensable, for with the rapid communication which exists in our times, and which has been extended even to India, the public opinion of great provincial towns may be as effective as that of any capital.

Even centrality of position has, by the discoveries of steam navigation, the railway, and the telegraph, become of far less importance than it once was. The same discoveries have contributed to diminish greatly the risks of domestic insurrection, and as to danger from a foreign enemy, our substantial protection is not local, but rests on England, and the pre-eminence of England's navy.

The author of the paper points out the neighbourhood of a town called Nassick as the most suitable site for a new capital of India. Nassick is an inconsiderable Mahratta town, and a famous place of Hindoo pilgrimage. It has a fertile territory, is but 120 miles from Bombay, and on the line of one of the great railways; but then it is two degrees within the Tropic, and but 2,000ft. above the sea-level, so that its summer heat cannot but be very considerable. Nassick did not receive the general approval of the able and experienced Indian officers* who discussed the question at our meeting. Some of the speakers expressed a favourable opinion of the Neilgherry Hills, a mountain range which covers an area of 600 square miles, and already the seat of several *sanataria*, and which contains several extensive plateaux, which rise from 5,000 to 7,000ft above the sea-level, with a reduction of temperature corresponding to these altitudes, and not unlike the climate of an English summer, although lying between the 10th and 11th degrees of latitude.

Delta of the Indus.—In the course of the session, a paper of eminent ability on the Physical Geography of the Lower Indus, was read by Col. Tremenheere. It gave rise to a spirited discussion on a disputed question of engineering; but as engineering is not a special branch of geography, we, according to our usual practice, offered no opinion of our own. Exclusive of all theory, however, the subject of Col. Tremenheere's communication, which includes in a direct line to the sea 330 miles of the lower course of the Indus, and, incidentally, the harbour of Kurrachee, the only navigable entrance to the Indus, is of unquestionable importance.

The Indus, with its harbour, Kurrachee, I may observe, is to Western India what the Ganges and Calcutta are to Eastern India. No doubt the Indus and its affluents, passing as they do through a comparatively sterile and underpeopled region, are of far less value to agriculture than the Ganges with its affluents, which water the most extensive, fertile, and populous parts of India; yet it has its special advantages. For vessels of burden its navigable course is more extensive; it is our natural frontier at the only quarter from which our Indian dominion can be assailed, while it is the great highway to the possible points of attack. The port of Kurrachee has even some advantages over that of Calcutta. The navigable difficulties incurred in reaching it from the open sea extend only about ten miles, while in the case of Calcutta they extend over 150. Kurrachee has, besides, the advantage of being from 2,000 to 3,000 miles nearer to England—the true source of our Indian wealth and power—than Calcutta. Kurrachee was, like Calcutta, a small village when we took possession of it only twenty-four years ago. It is now a considerable, well-built town, and its importance as a commercial emporium may be judged by the following simple fact. Its joint export and import trade in 1844 was of the value of £122,160, and on the average of the four years ending with 1866, it amounted to £5,500,000.

Independent of the political and commercial advantages of the Indus, with its harbour, it is not to be forgotten that Kurrachee is the only port existing on the western side of India, with the exception of the fine one of Bombay. India, meaning by this the proper country of the Hindus, is, for a great, populous, and wealthy region, singularly deficient in good harbours. On its eastern side it has not one until we arrive at the head of the Bay of Bengal, where we find Calcutta, made tolerably safe, only by dint of great skill and heavy cost. It is worth notice, in a geographical sense, that the opposite coast of the same gulf forms, in this respect, a singular contrast, for here we have no fewer than four good and safe harbours, Negrais, Rangoon, Martaban, and Mergui, the three first being also the embouchures of navigable rivers. If we include Penang, which is on the same coast, we have five harbours, while large and populous Hindustan has but three.

Kurdistan.—In the mountainous region immediately to the north of the plains of Mesopotamia, and around the sources of the Tigris and Euphrates, our Consul at Diarbekr, Mr. I. E. Taylor, has been doing good work of late years in advancing geographical and archæological knowledge. In a former session of our society, Mr. Taylor communicated to us the results of his researches during the years 1861-3, when he explored the eastern head of the Tigris, verifying the description of Strabo, and discovering near it a record of an invasion of the country by one of the Assyrian monarchs. Returning, in 1865, to the scene of his labours, after a short visit to England, this persevering explorer has continued his researches in the direction of the Kara Su River, or Lycus of the ancients He has lately sent us a brief preliminary account of this last journey, stating that he has traced this river to its sources and discovered the site of Pompey's Nicopolis. A more detailed account of these explorations, together with a map of his routes over districts never before visited by a European in modern times, is promised by Mr. Taylor, and will doubtless form the subject of discussion at one of our evening meetings early in the next session.

Egypt.—*The Great Pyramid.*—Among recent publications, I must not omit to notice Professor Piazzi Smyth's "Life and Work at the Great Pyramid." If our Government of late years has seemed too often chargeable with indifference to the promotion of scientific research in foreign nations, and even in its own dominions, there are still private Englishmen ready to devote their time and means to such researches. And as it is to the labours and munificence of one Englishman (Colonel Howard Vyse) that Europe owes all the most important discoveries regarding the general structure of the Great Pyramid, so now to the indefatigable work of another we owe the most minute and scientifically accurate measurement of its details that has ever been executed.

Before his visit to Egypt, Professor Smyth had become an enthusiastic advocate of the late John Taylor's theory of the Pyramid as a great metrologic record; and it was his desire to test and develope this theory by more accurate measurements, that carried him to Egypt. His stay there has enabled him to produce a book of great interest, both in the narrative of his operations and in their results; and its connection throughout with metrology, in the most comprehensive sense of the word, renders it a fit work for the consideration of the Geographical Society. Some of the measurements were performed under remarkable advantages, for Professor Smyth had the good fortune to see the whole four of the corner-sockets of the Great Pyramid, as originally excavated in the living rock, uncovered simultaneously for the first time on record. Yet the important measurement between those fiducial points was sorely obstructed by the masses of rubbish that surround the pyramid, the removal of which is too costly for private means. Professor Smyth shows clearly that the Great Pyramid is not merely the greatest of a class, but stands *alone* in its proportions and constructive arrangements. He shows that though its entrance passages were so carefully sealed, the details of their elaborate structure clearly point to the anticipation of future disclosure, whilst marks indicating the way to such disclosure have even been discovered by Professor Smyth in the masonry of the first descending passage. He has gone far towards establishing beyond doubt the fact—which many still reject—that the pyramid was originally cased with smooth Mokattam limestone (not granite, as some have stated). His measurements demonstrate that the pyramid is (or rather has been) a true symmetrical figure on a square base, the orientation of the sides of which deviates from the truth not more than 5 minutes at most, whilst their *mutual* deviation does not exceed 35 seconds. They prove that the altitude of the pyramid is to the perimeter of its base in the ratio of the radius to the circumference of a circle; that the number of cubits in the length of the base, symbolises to a fraction the length of the solar year; that the cubical capacity of the lower course of the King's chamber is just 50 times the interior content of the granite coffer which stands within it; whilst the exterior capacity of the coffer is just double its interior contents. These are only a very few samples of the results of the measurements in which Professor Smyth conceives that he finds the records of a metrologic system of the most scientific kind; of a standard of length based on the length of the earth's semi-axis of rotation; of standards of weight and capacity based on the earth's mean density and on the preceding standard of length; of time standards in the length of the year and the record of the Sabbatic week; nay, of a standard of thermometrical and a scale of angular measurement. Some of Professor Smyth's concluding speculations and deductions are, doubtless, a little eccentric, and the least questionable of his results are astounding. But whatever may be thought of the more startling parts of the book, as a whole it is the record of a great undertaking scientifically executed, and it will doubtless produce much discussion among antiquaries and astronomers as well as geographers.

South America.—In my address for last year I fully discussed, with the valuable aid of Sir Woodbine Parish, the geographical questions which were

* For the various opinions expressed by Sir Henry Rawlinson, Sir Charles Trevelyan, Sir Robert Montgomerie, Sir Erskine Perry, and others, *see* "Proceedings" R.G.S., vol. xi., p. 74.

solved by the exploration of the river Purûs by Mr. Chandless. That most accurate observer ascertained beyond a doubt that the main branch of the great stream, which he ascended nearly to its source, did not extend to the mountain ranges of Peru. We have since received a full account of the second voyage of Mr. Chandless up the Purûs, and of his exploration of its principal affluent the Aquiry, which he undertook in the season of 1865-6. He found no difficulty in navigating the Aquiry for the first 300 miles, even at the lowest stage of water, and considered it to be perfectly navigable for steamers up to the parallel of 11°. Higher up it became wider and shallower, and his canoe was finally stopped by a network of stranded timber. After navigation became impossible, Mr. Chandless attempted to reach some river belonging to the Madre de Dios system, flowing from the Andes. He forced his way for a considerable distance through an almost impenetrable forest, but, at the end of a week, was obliged to return for want of provisions.

While Mr. Chandless was thus, by an exhaustive process solving, in the negative, the question whether the streams flowing from the Cordilleras of Cuzco and Caravaya formed the river Purûs, our Peruvian honorary corresponding member, Don Antonio Raimondy, was furnishing us with information as to their true course. It appears, from our correspondent's narrative, that the enterprising Peruvian explorer Don Faustino Maldonado constructed a canoe in February, 1861, and embarked on the Madre de Dios with seven companions. He was drowned in passing a rapid, but his surviving comrades continued the voyage, entered the great river Madeira, and eventually reached Manaos on the Amazon, at the mouth of the Rio Negro. As the Beni is the only large river which flows into the Madeira on its left bank, it would appear that the rivers Madre de Dios and Ynambari, flowing from the Cordilleras of Cuzco and Caravaya, and which were so long supposed to be the sources of the Purûs, are in reality tributaries of the Beni. Senor Raimondy's own valuable labours have comprised a careful examination of two tributaries of the Ynambari, in the province of Caravaya; but it is his intention to continue the exploration of this interesting and very important region in future years.

It is with great satisfaction that I have to announce the departure, by the last Brazilian mail steamer, of that most indefatigable and accurate scientific explorer, Mr. Chandless, to the scene of his former labours and triumphs. It is his intention, on this occasion, to ascend the rivers Madeira and Beni, and thus at length to reach those streams flowing down the forest-clad slopes of the glorious Eastern Andes, which he had previously sought in vain at the head-waters of the Purus and Aquiry. We shall look with much interest to the results of our medallist's further explorations.

While on the subject of South America, I may mention that the attention of the present energetic and enlightened ruler of Peru, Col. Don Mariano Ignacio Prado, has been turned to the opening up of the great fluvial highways between the Peruvian provinces in the Andes and the main stream of the Amazons, chiefly by way of the Pachitea, a river which our Lieutenant (now Admiral) Smyth endeavoured to reach in his courageous exploration of the year 1834. Three steamers were employed last year in exploring the Ucayali and Pachitea, and succeeded in reaching Mayro, 325 miles from Lima, on the 1st January, 1867; thus proving the Amazons to be navigable for 3,623 miles, from its mouth to the eastern slopes of the Andes near Lima. The hitherto almost unknown River Javari has also been lately explored, to the extent of about 1,000 miles, by a joint Peruvian and Brazilian boundary commission. This laudable activity, while developing the resources of these countries, cannot fail to extend geographical knowledge.

Australasia.

In my last address I recorded the progress of the expedition in search of Leichhardt, which had been organised by a committee of ladies at Melbourne, incited by our learned and enthusiastic associate, Dr. F. Mueller, and which had been munificently supported by grants from the Colonial Legislatures, besides donations from the Queen and our own society. Since then the able leader of the expedition, Mr. Duncan McIntyre, much to the grief of the promoters, has fallen a victim to a malignant fever now prevailing along the banks of the streams which flow into the Gulf of Carpentaria.* Before this unfortunate event occurred, McIntyre had made good progress in searching for traces of the long-lost party, along the banks of the Albert, Gilliot, and Leichhardt rivers; questioning the natives, and examining all the reports of white people living amongst the tribes. His journey across the continent, however, from the River Darling to Burketown, on the Albert, has added but little to our geographical knowledge, the party having followed very nearly on the tracks of the former explorers, McKinlay and Landsborough. The death of Mr. McIntyre occurred on the 4th of June last; and I have lately learnt that Mr. W. F. Sloman, who succeeded to the command, has since also died. In this state of affairs, with the expedition left to itself on the opposite side of the continent, the Ladies' Committee have entrusted its further management to Mr. Campbell, the uncle of the late leader, who has contracted to continue the search for the remainder of the two years originally contemplated, and has appointed Mr W. F. Barnett as leader. By the last accounts from the Gulf of Carpentaria, dated December 21st, the party has resumed the search, and had obtained a valuable coadjutor in Dr. White; the camels were reported as in fine condition, and well suited for Australian travel.

In other parts of Australia the acquisitions to our geographical knowledge have been limited to local explorations in search of lands suitable for pasture or settlement. This has been especially the case with the colony of Western Australia, which has of late years added much to our information respecting the northern portions of its territory. Mr. R. J. Sholl has explored the neighbourhood of the Glenelg River and Camden Harbour, but without hopeful results as regards its capabilities for immediate settlement; and on his report the Provincial Government has abandoned the attempt to colonise the district. The settlement of the northern territory of South Australia has also proved a failure, and is now abandoned—the survey of the neighbouring coasts and rivers undertaken by the colony, with a view to discover suitable lands for colonisation, having borne no fruit. On the other hand, the progress of settlement in the tropical portions of Queensland, on the eastern coast, and at the head of the Gulf of Carpentaria, steadily continues. Another new township, named Carnarvon, has been formed in the Gulf, on Sweers' Island, to the north of the mouth of Albert River, where the harbour, named by Captain Flinders "Investigator Roads," is the only good one at the head of the Gulf. This is probably destined to become the principal seaport in this part of Australia, and the emporium for the settlements on the banks of rivers running into the Gulf. Upon the general subject of the advance of colonization in Queensland I entered into some detail in my last address, and need not now recur to it, beyond calling your attention to the able descriptive paper of Mr. John Jardine,* which gives so much information regarding the neighbourhood of our new settlement of Somerset, at Cape York.

New Zealand.—Since the publication of the valuable papers of Dr. Haast and Dr. Hector, on the glaciers and passes of the Canterbury and Otago Provinces, in the Middle Island, New Zealand, in the 34th volume of our Journal, the exploration of the rugged and almost impassable mountain-range which forms the backbone of island, has been continued by the former of these gentlemen. Owing to the discovery of gold on the western coast at Hokitika, the Provincial Government of Canterbury were anxious to discover some nearer route over the mountains than the circuitous one by the Hurunni and Teramakau or Harper's Pass; and several parties were sent out to find, if possible, other passes. From this resulted the discovery of Arthur's Pass (3,038ft.) near the head-water of the Waimakariri, by Messrs. Arthur and George Dobson, and the north Rakaia Pass (4,645ft.) by Messrs. Browning and Griffiths, which latter reduced the distance between the east and west coasts by about eleven miles. On Dr. Haast devolved the duty of examining these different passes, and preparing a series of altitude sections by barometrical observations, to serve as a guide to the Government in choosing the best route. The task was accomplished in the latter part of the year 1865; Dr. Haast traversing the various passes, and, on his return to Christchurch, drawing up a series of admirable diagrams in illustration of the subject, copies of which, together with a descriptive paper, he has forwarded to me for presentation to our society. The north Rakaia Pass was found by Dr. Haast to be deeply covered with snow in the early summer, and he states that the routes by Arthur and Harper Passes (although considerably longer) will always be preferred by travellers, as they are seldom obstructed by snow, and are not subject to avalanches.

Conclusion.—In concluding this, the thirteenth, address, which I have delivered to you, I must now assure you that the Council ought to have selected some one younger than myself to occupy your chair. For in truth, my numerous avocations press so heavily upon me, that, with the heartiest desire to serve you, I am too well aware of my inability to efficiently perform all I could wish. Permit me, however, to explain, that if this address is not as complete as it ought to be, my chief apology is that, as our anniversary approached, I was in the throes of bringing out a new edition of the chief work of my life, "Siluria.' But whilst geology has been the pursuit on which I have established whatever little reputation I possess as a labourer in the fields of science, I know that you will believe me when I say that I have so loved geography that I have through life considered these two great branches of knowledge to be inseparably connected. At all events, during my term of office as your president, I have ever striven to the utmost of my power to preserve the efficiency and augment the influence of the Royal Geographical Society.

If, then, you should be pleased to adopt the recommendation of the Council, and re-elect me, I promise you that, if I be spared, I will put forth what energy remains in me to carry out your wishes during the ensuing year. But really, when that term shall have expired, I trust you will place at your head a younger chief; and whoever he may be, I am sure when he been but a year in office he will declare, as I have ever done, that the Fellows of this Society are men of whose support he may well be proud, and over whom it is a true honour to preside.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

The last ordinary monthly meeting of the Executive Committee of this Association was held at the offices, 41, Corporation-street, Manchester, on Tuesday, August 27th, 1867, William Richardson, Esq., C.E., of Oldham, in the chair, when Mr. L. E. Fletcher, chief engineer, presented his report, of which the following is an abstract:—

During the past month 195 visits of inspection have been made, and 420 boilers examined, 218 externally, 11 internally, 8 in the flues, and 153 entirely, while, in addition, 2 have been tested by hydraulic pressure. In these boilers 165 defects have been discovered, 9 of them being dangerous.

Furnaces out of Shape.—The boiler in which this defect was met with was of the internally-fired double furnace class, measuring 7ft. in diameter and 30ft. long, and worked at a pressure of 60lbs. per square inch. The furnace tubes, which were 2ft. 7½in. in diameter, had originally been strengthened with T iron hoops at each of the ring seams of rivets, but some slight defects having

* I am informed by Sir George Bowen, Governor of Queensland, in a letter, dated 16th December, 1866, that the last accounts report an improvement of the public health in these districts.

* See "Journal R.G.S.," vol. xxxvi., p. 76.

manifested themselves at the seams over the fire, the first three T iron hoops were removed, and the furnace tubes renewed with Low Moor plates three-eighths of an inch in thickness, and put together with the ordinary lap-riveted joints, instead of the hoops. The furnace crowns, however, gave way again, and for about the last month have been gradually bulging downwards, having now deflected an inch and a half.

The distortion of furnace crowns is usually due to overheating of the plates through shortness of water, but it is not generally known that overheating may arise even when there is an ample supply of water in the boiler, and the plates over the fire are covered. Such, however, is not infrequently found to be the case, and it would appear that some waters, which form a fine floury deposit, especially if they be heated by the injection of the exhaust steam from the engine before being pumped into the boiler, are especially prone to lead to the bulging of the plates over the furnace when the firing is severe. Several cases of this character having come under my notice, and in one of them an entire series of six new externally-fired boilers being injured, it appeared to me that the subject was worthy of special reference, and I am, therefore, having some of the waters analysed, for the information of our members, and propose to refer to it again as soon as the different analyses are completed and illustrations prepared.

EXPLOSIONS.

I have no explosion to report for the past month. As pointed out on a previous occasion, they are not recurring with the same frequency this year as they have done in preceding ones, the number reported from the commencement of the year up to the close of this month's return being only 18, resulting in the death of 28 persons, and injury to 33 others. Whereas during the corresponding period of last year 40 explosions occurred, resulting in the death of 48 persons, and injury to 72 others. This opportunity may be taken of referring to two explosions which occurred last month, but notice of which was not received in time for the last report. Neither of the boilers in question was under the inspection of this Association.

No. 15A Explosion occurred at an ironworks, at six o'clock in the evening of Wednesday, July 10th, and resulted in the death of one person, as well as in injury to two others.

The boiler, which was one of a series of three, all of Balloon or Haystack construction, was of large size, being about 22ft. in diameter in the domed head, and 20ft. 9in. at the bottom, where it rested on the brickwork. The original thickness of the plates had been about seven-sixteenths of an inch at the top, and half an inch at the bottom over the fire, while the safety-valve was loaded to about 9lbs. per square inch.

The boiler gave way at the bottom, tearing all the way round where it rested on the brickwork seating, just at the attachment of the bottom to the sides, in consequence of which it flew upwards, turning upside down in its course, and falling on to one of the adjoining boilers. The bottom being connected to the upper part of the shell by numerous stays, was not entirely severed from it, but carried along with it.

The explosion was due simply to the dilapidated condition of the boiler, the plates at the bottom, where they rested on the brickwork, being severely attacked by external corrosion, and considerably reduced in thickness nearly all the way round the seating, while for a length of 9ft. they were almost eaten through. Low as the working pressure was, it was yet amply sufficient to cause the explosion, on account of the large diameter of the boiler, the strain to sever the top of the shell from the bottom with steam at a pressure of only 5lbs. per square inch being as much as 100 tons in round numbers, which it will be seen is quite enough to account for the boiler's being lifted from its seat. Timely inspection and repair would have prevented this explosion.

No. 17 Explosion occurred on the morning of Wednesday, July 24th, to the boiler of a locomotive engine. The engine was attached to a passenger train, and was just in readiness for starting when the boiler burst, severely scalding the fireman, but fortunately not injuring any of the passengers. I have not as yet been able to procure sufficiently detailed information as to the condition of the boiler, to enable me to report on the cause of the catastrophe, but may perhaps state that the majority of explosions occurring to locomotive boilers, which I have hitherto investigated, have been due to grooves or furrows eaten into the plates close to one or more of the longitudinal seams of rivets in the cylindrical portion of the boiler. This is the second locomotive explosion which has occurred during the present year.

ECONOMY OF FUEL AND PREVENTION OF SMOKE.

The present high price of fuel, and the amount of public attention now directed towards the abatement of the smoke nuisance, render economy of fuel and smoke prevention matters of considerable interest. I may, therefore, venture to mention to the members of this Association, that a number of Lancashire and Cheshire coal owners, who have formed themselves into a society called the South Lancashire and Cheshire Coal Association, have for some time past been carrying on, at considerable expense, a most elaborate series of experiments bearing directly on these subjects, the objects of these experiments being, in the first place, to test the economic efficiency of the coals of this district, and in the second to ascertain the most economical form of boiler, the best mode of firing, whether mechanically or by hand, so as to evaporate the greatest amount of water with a given quantity of coal, without the production of smoke. These experiments, which have been conducted on a large scale, and have already occupied upwards of eighteen months, have entailed considerable expense, which has been borne by the South Lancashire and Cheshire Coal Association, while they have been conducted under the joint superintendence of the late Dr. Richardson, of Newcastle, and myself, and are not yet completed, but are still in daily progress. I trust at some future time, by the permission of the Coal Association, to be permitted to publish some of the details of the trials in this Association's monthly reports for the benefit of our members, while I may venture to state in the meantime, that as far as these trials have hitherto progressed, they have clearly shown that the formation of smoke may be entirely prevented without any diminution of the evaporative efficiency of the coal, by careful firing alone; while it has been found, in addition, that the coals raised in this district will realise as high an economy and efficiency as the best north country and Welsh coals, and that without the production of smoke. I hope to refer to this subject again on a future occasion. Economy of fuel, as well as smoke prevention, is becoming of daily increasing importance, and is a matter on which I am most desirous of rendering our members every assistance.

SHIPBUILDING IN THE NORTH.

Iron shipbuilding, which has so long been depressed in the north-eastern ports, shows some signs of improvement. Messrs. Palmer and Co. (Limited), at Jarrow, on the Tyne, have got orders recently, it is reported, to build two steam vessels, of over 3,000 tons each, and one of 2,000 tons; and the same firm have a steamship of 3,200 tons, a vessel of 2,000 tons, and an iron sailing ship on hand. The latter is zinc coated below water to prevent fouling. The same firm are also building, at their Howdon-yard, an extensive iron bridge for the East India Railway Company. Messrs. Charles Mitchell and Co., of Low Walker, have despatched a powerful new screw steamer, the *Emperor*, to London this week. She has been taken up by the Government for the Abyssinian expedition, and will be fitted up in the Victoria Docks to carry mules. The same firm launched, on the 14th inst., the *Tchehatchoff*, a vessel of 2,500 tons, and 160 horse-power, for the Russian Steam Navigation Company, to be employed in the Black Sea trade; and they are also building a double-screw gunboat, to be used for harbour purposes. She is built after a design made by Mr. Rendell, C.E., and it is intended to arm her with but one large Armstrong gun. It is stated that Messrs. Palmer and Co., of Jarrow, are likely to receive an order from the Government to build a gunboat of the Monitor class. As on the Thames, a considerable body of workmen connected with iron shipbuilding have been out of employment on the Tyne this summer. The building of tug-steamers has been slack on the Tyne during the summer, but a few more orders are coming to hand. Timber shipbuilding keeps slack on the Wear. Nine years' ships, coppered, and with a complete outfit, may be had under £11 a ton, and vessels of a higher class in proportion. No price can be set upon old ships. They are a complete drug, and vendors get what they can for them.

CAST-IRON PIPES.

ENGLISH *v.* COLONIAL.

The following is the specification recently issued by the Sydney Municipal Council, for the supply of 4,400 iron pipes:

Specification to be observed by the contractor for supplying to the Municipal Council of Sydney certain cast-iron pipes.

This contract consists of the supply of all the materials, labour, works, machinery, tools, &c., requisite for the manufacture of certain straight cast-iron pipes, according to the description and dimensions given in this specification and the accompanying drawings.

These pipes, 4,400 in number, shall be of the description generally understood by the term "socket pipes." They are to measure, when in the work, 9ft. in length, and be made to the dimensions given in the annexed schedule, and shapes shown in drawing annexed hereto.

The whole of the pipes shall be cast vertically, and the body of each pipe must have an uniform thickness of metal throughout its length, excepting in the socket, and they must be truly cylindrical in the bore, and have their inner and outer diameter as nearly as possible concentric.

The whole of the pipes shall be made in every respect of such dimensions as may be given in the schedule annexed hereto, and according to the shapes shown by the accompanying drawings, and shall consist of sound castings entirely free from scoriæ, sandholes, air bubbles, cracks, or other defects. The pipes shall be tested to a pressure equal to a column of water 300ft. in height, to be applied in such a manner as may be directed or approved by the agent appointed by the Municipal Council to superintend the execution and fulfilment of this contract; who shall have full power to appoint an inspector to examine and test such pipes at the works of the contractor or maker, or both, as the agent may think proper, and the contractor shall provide all the necessary labour, machinery, works, &c., for the purpose.

And should any pipe or pipes during such examination and test be found defective, or in any way inferior to the description of water pipes required, they will be rejected, and shall be replaced by the contractor by such other pipes as may be found under the aforesaid test and examination, to fulfil the conditions of this specification.

The estimated weight per pipe is given in the schedule annexed hereto, which is the minimum weight that will be received; but an excess will be permitted in each pipe beyond such estimated weight to the amount given in the annexed schedule, beyond which no payment will be made for additional weight.

The contractor must commence shipping the pipes within five months after accepting this contract in Sidney, and he must enter into a bond to the extent of £500 sterling, to deliver the whole of the pipes herein stated, on a wharf in Sidney, sound and in good order, and fulfil the conditions of this specification within twelve calendar months from the date of signing this contract; but in case of accident by sea, the contractor will be allowed a reasonable extension of time, at the discretion of the Municipal Council, to deliver any pipes which may have been lost or detained by such accident.

Payment will be made on behalf of the Municipal Council in cash to the extent of sixty-five per cent. of the contract price per ton, on the shipment of each parcel, and the delivery to the London bankers of the Municipal Council of Sydney of the bills of lading, together with the certificate of the agent of the Municipal Council, that the pipes have been inspected, stamped, and proved by him to fulfil the conditions of this specification. The balance of 35 per cent. of the contract price to be paid to the contractor on delivery, in accordance with the terms of this specication of each parcel of pipes in Sidney.

The whole of the pipes included in this contract are to be coated with black varnish, under Dr. Angus Smith's patent process, to the entire satisfaction of the agent of the Municipal Council of Sydney, and the cost of which is to be included in this contract.

The tenders must contain the price per ton for the pipes mentioned herein, delivered in Sidney, in accordence with the terms of this contract.

No. of each description of pipe.	Internal diameter of pipe in ins.	Thickness of metal in the barrel.	Length of each pipe when in the work.	Estimated weight of each pipe. Minimum.			Remitted excess of weight.
		ins.	ft.	cwt.	qrs.	lbs.	lbs.
300	12	·62	9	6	3	21	18
300	9	·56	9	5	0	22	15
800	6	·50	9	2	3	17	12
2,000	4	·45	9	1	3	4	10
1,000	3	·375	9	1	0	14	8

COMPLETION OF ONE OF THE LARGEST ARMOUR PLATES IN THE WORLD.

One of the finest, thickest, and heaviest armour plates ever rolled in the world, was recently pressed into the very perfection of a manufactured armour plate at the great Atlas Ironworks of Sir John Brown and Co., Sheffield. The size of this monstrous slab of iron when in the furnace was a little over 20 feet long by about 4 feet broad, and 21 inches thick. Its rough weight was over 21 tons. It was built np in the furnace before being rolled by five plates, each three inches thick, and one plate of six inches. The plate when laid in the furnace rests upon little stacks of fire bricks, so that the flame and heat play equally around it till it is all glowing white, and the successive layers have settled down into one dense mass. As the time for "drawing" approached, bands of workmen, to the number of about 60, arranged themselves on each side of the furnace, as near to it as they could bear the heat. Then the doors were opened to their fullest, and what had been a glare before, and what had been a heat were quite eclipsed by the intense light and fervency with which the long tongues of flame leapt forth. In the midst of this great light lay a mass even whiter than the rest. To this some half a dozen men drew near. They were all attired in thin steel leggings, aprons of steel, and a thin curtain of steel wirework dropping over their faces like a large, long visor. All the rest of their bodies were muffled in thick, wet sacking. Thus protected they managed, with the aid of a gigantic pair of forceps slung from a crane above, to work as it were amid the flames for a few seconds, and to nip the huge plate with the forceps. The signal was then given, and the whole mass of iron, fizzing, sparkling, and shooting out jets of lambent flame, was by the main force of chains attached to the steam rollers, drawn forth from the furnace on to a long wrought-iron car. The heat and light which it then diffused were almost unbearable in any part of the huge mill, but the men seemed to vie with each other to approach and detach the colossal pinchers which had drawn the iron forth. More than a dozen attempts were made before this was effected, and more than a dozen of the best and most skilful workmen were driven back one after another by the tremendous heat and glare. At last all was made clear. The forceps was drawn away, the chains cleared from the rollers, and the other workmen seized the chains attached to the iron truck, and drew it to the incline by main force, where it was left by its own weight to run into the jaws of the rolling-mill. The workmen rushed for shelter in all directions as the mass was nipped between the rollers, and wound rapidly in amid quick reports like those of dull musketry, as the melted iron was squeezed by the tremendous pressure out of the mass, and flew out in jets of liquid fire on all sides. The turning of the rollers crushes the plate through to the other side, where it rests for a minute on a wrought iron truck similar to that on which it was brought from the furnace. The action of the rollers is then reversed after they have been brought closer together by about an inch. These again nip the plate and drag it back in an opposite direction, and again and again does this mass go forward and backwards, each time passing between a smaller space, till the whole of the huge thickness was reduced to a compact mass 15in. thick, in a quarter of an hour. During every stage of the process quantities of fine sand are thrown upon the plate, and this takes fire as it touches the flaming surface, and covers it as it melts with a coat of silica, or with a glaze like that of earthenware. After every discharge of sand, and these go on almost incessantly, buckets of water are thrown upon the plate and explode in scalding steam, and when these are partly dissipated, men rush forward and with wet besoms with handles 20ft. long, sweep off whatever little scraps of oxidation may have taken place. Thus, every time the plate passes through the mill, the sand is scattered, the water thrown, and the surface swept, and at every roll the chief roller of the establishment runs forward, and under the shelter of wet clothes, measures with a gauge its thickness end to end. The required dimensions were obtained, as we have said, by less than a quarter of an hour's rolling, and a plate 15in. thick, the product of the labour of nearly 200 men and of the consumption of nearly 250 tons of coal, was shot out by the rolling mills and left to cool. When this had been effected, two large rollers of iron, each weighing 15 tons, were left upon its ends to keep the whole perfectly level. Nothing further now remained in order to complete it as the finest specimen of armour plate manufacture ever attempted but to plane off its rough ends and edges. The flat surfaces on either side, which form what is called the skin of the plate, are never interfered with, for the action of the steel rollers leaves them literally almost as smooth as plate glass.

ENGINEERING, etc., IN SCOTLAND.

Trial of the Potato Diggers.

The trial of the potato diggers selected to compete for a £20 premium came off on the farm of Bearyards, belonging to Mr. Warnock, near Bishopbriggs Station. The field on which the operations were conducted is extensive, and the growing potatoes, though not yet ripe, presented a very good appearance. Large numbers of farmers from many different parts of the country, and others interested in agricultural implements of all descriptions, were present, and the utmost interest was evinced as to the performances of the various machines. The weather was fine, and by twelve o'clock eight "diggers" were on the ground. The competitors were—Mr. George Cowan, Drem, East Lothian, one digger; Mr. Wm. Kirkwood, Dalkeith, two; Messrs. Law, Duncan, and Co., Shettleston, one, Hanson's patent; Mr. Thomas Reid, Monckton, Ayr, one; Mr. Peter Winton, Falkirk, one; Mrs. Sheriff, Westbarns, one; and Messrs. Ransomes and Sims, Ipswich, one. Of the eight machines, however, only five were found entitled to compete, the remaining three being there merely for exhibition, or were excluded on account of having been altered since the show in Glasgow. The judges on the ground were—Mr. Laurence Drew, Merryton; Archibald Russell, Flemington, Cambuslang; John Wallace, Stonelaw; William Robertson, Oldlaw, Paisley; and Mr. Robert Murdoch, Hallside, Cambuslang. Mr. Cowan's digger was the first tried, and though it did good work the result was not considered on the whole very satisfactory. One of Mr. Kirkwood's was next started, but with a similar result. The third was the one in which the interest of the day was centred—that of Messrs. Law, Duncan, and Co.—Hanson's Patent. This admirable machine, which has been in operation for the last nine or ten years, has been known to excavate six acres of potatoes in little over two hours, and find work for sixty people in that time as the gatherers of the potatoes thrown out on the surface of the land—hardly leaving a single tuber of any valuable size behind. The machine, so well known to implement makers, moves on two bearing wheels, which are made by means of iron wedges, projecting from the tyres of the wheels, to dig into the soil. This gives the necessary reaction to the operative part of the machine. A combination of wheel work, acting on a shaft, gives motion to a series of arms, forming together so many spokes, eight in number, which have three forked extremities. These spokes rotate at right angles to the direction of draught, or of the line of the potato drill, and strike the body of earth that has already been loosened below by

another part of the machine, and dislodge the whole mass, earth and potatoes together; but the fingers or forks riddle out the potatoes, and to prevent their dispersion a wire screen or netting carried by the machine is hung out to intercept any flying potatoes. The mould cushions the potatoes from the merciless strokes of the forks, and none of them are hashed or broken. This machine was tried repeatedly, and the result was in every case such as to prove the very effective and valuable character of the digger. Mr. Reid's digger was the next one put to the test, after which that of Mr. Winton was tried, but did not complete its course. The judges having looked at the performances of those machines sent in for exhibition and not for competition, retired and gave their decision in favour of Messrs. Law, Duncan, and Co., Shettleston (Hanson's patent); and the next place to Mr. Thomas Reid, Monckton, Ayr.

TRIAL OF THE REAPING MACHINES.

The trial of the reaping machines selected for competition from those exhibited at the late Highland Society's show took place at Glasgow on the 2nd of September, on Hamilton Farm, near Cambusland. There were four different classes of machines tried, viz., combined reaper and mower, two-horse reapers, one-horse reapers, all with manual delivery, and two-horse reapers with self-delivery. Of the first-mentioned class, the following makers' machines were put to work:—Messrs. J. Wallace and Son, 7, Graham-square, Glasgow; Messrs. Brigham and Bickerton, Berwick-on Tweed; Messrs. Lillie, Goodlet, Elder and Co., Berwick-on-Tweed; and Messrs. Alex. Jack and Sons, Maybole. To each of the machines was allotted about two Scotch acres of grain, and they nearly all completed their tasks within the two hours. There were no premiums given, but at the conclusion of the competition the judges announced that, in their opinion, the machine shown by Brigham and Bickerton was the best, and that the next in order of merit was Murray and Nicholson's. A trial afterwards took place of two-horse reaping machines, as to which the judges declined to express an opinion, the trial not having been, in their opinion, a satisfactory one. The one-horse reaping machines were afterwards tried, that shown by Messrs. Horneby and Sons, Grantham, being declared first, and Messrs. Samuelson and Co.'s second. The last competition was that of the two-horse reapears, with self-delivery. Considering the laid and twisted condition of the crop they had to deal with, all the machines worked well, but, as in the second class, and for the same reason, the judges would give no decision. The results of the trial of the several machines in the competition, on which the judges gave their judgment, will be seen from the subjoined table:—

Makers.	Extent of Plot.	Width of Cutter.	Average Cut.	Ditto, when tested.	Draught by Dynamometer.	Time taken.
	rds. pls.	ft. ins.	ft. ins.	ft. ins.	cwt.	h. m.
Wallace & Son.........	2 31	5 0	3 6 to 4 0	3 3	4	1 50
Brighton and Bickerton	2 34	4 11½	4 3 to 4 6	4 3	3½	1 33
Kemp, Murray, and Nicholson	3 3	5 0	4 0 to 4 6	3 3	4	1 54
Lillie, Goodlet, Elder, and Co.	3 4	4 9½	3 6	3 6	3½	1 57
Jack and Sons	3 5	5 0	3 6	3 6	3½	2 10

One or two qualifying remarks may not be out of place regarding these machines and their work. Messrs. Brigham and Bickerton's was the only one which had no serious "hitch" It possesses all their latest improvements, and is termed iron-framed "Buckeye" Machine. It was rarely brought to a standstill by any materials entangling the wheels or other parts of the gearing; it worked smoothly, did the sheaving well, and left a very fair stubble. The only one which came close upon its heels in these particulars was that owned by the Stirling firm. It had, however, a large plot of corn to reap, one that was also more severely laid and twisted than either No. 1 or No. 2. The platform of this machine was peculiar in the circumstance that it was sparred, all the others being plain and covered with sheet zinc, to give such a degree of smoothness as would facilitate the making of the sheaves. No. 1 had a serrated cutter, and in this sense it was peculiar, as all the others had plain teeth. From choking or other circumstances it came to a standstill more frequently than either of the two just referred to: but in this respect it was outstripped by those owned by Messrs. Lillie, Goodlet, Elder, and Co., and Messrs. Jack and Sons. These two, however, had to attack the worst portion of the crop, where it was in many places quite "heads and thraws," in fact.

Taking all the circumstances into consideration—the quality and sizes of the plots, the mode in which the operation was executed, the corn after cutting, and the condition of the stubble—the judges had no difficulty in awarding the first place to Messrs. Brigham and Bickerton's "Buckeye" reaping-machine, and the second to that of Messrs. Kemp, Murray, and Nicholson. It should be mentioned that the Highland and Agricultural Society does not make any pecuniary award in respect of these machines, or, indeed, in respect of implements or machines exhibited during several years; the money awards are all given for live stock and dairy produce. It is something, however, for Messrs. Brigham and Bickerton to be able to say that their "Buckeye" reaper has received the first award of the Highland and Agricultural Society, even though that award is only honorary.

AGRICULTURAL MACHINERY.

In section G of the British Association an important and valuable paper has been read by Mr. David Greig on the advantages to be derived from steam cultivation, its present position and future development; also a most interesting and instructive paper by the Rev. Patrick Bell, on reaping machines, their history, and particularly that of his own invention, which was the first machine that did its work well, when tried in 1827; since which it has required or undergone but slight and minor improvements, and has evidently given the character and type to all, or most of the reaping machines now in use in Europe and America. For the substance of these papers and the valuable remarks elicited from the experienced chairman and others, during the discussion of the subjects of the papers, we must refer the reader to our special report on the mechanical section given in our columns. These papers and discussions, however, culminate in the great importance of the application of machinery to all agricultural purposes possible—a subject (from the rising value of manual labour) alike important to all farmers, who ought to assist the development and introduction of such machinery, and to the enterprising agricultural engineers, whose duty it is to look before them and supply the recognised want by the production of such machines as stand the test in practice of fulfilling the ends for which they are designed. The gratifying fact that both farmers and agricultural engineers are fast becoming more and more alive to these wants, has been well illustrated by the great display of machinery previously noted by us, which took place at the show of the Highland and Agricultural Society, lately held at Glasgow, and subsequently by the interest displayed at the keen competition of potato digging machines and reaping machines, which trials came off on the 29th August and 2nd September respectively, with the results as reported beneath.

NOTES OF SHIPBUILDING AND MARINE ENGINEERING ON THE CLYDE.

TRIAL OF THE "NIAGARA," AND MR. ROBT. DUNCAN'S INVENTION.

Many surmises were passed at Port Glasgow when it was understood the fine ship *Niagara*, converted to a sailing ship from a paddle steamer, as explained in another column, would have a trial of the application to it of Mr. Duncan's auxiliary steam power for sailing vessels, many grave doubts being expressed by "old salts" as to the probability of a small boat containing the steam power being able even to move such a large vessel as the *Niagara* fully loaded. The result of the trial made at the tail of the bank, on the 13th ult., dispelled these doubts, and proved very satisfactory. The ship's boat, provided with an engine and screw propeller, as described in another column, having been made fast, and the full length of the cable having been given the ship, this novel little steamer canted her round with considerable ease, and moved her forward the full length of her cable, at a speed which was computed at at least 2½ miles an hour, and this in the face of a stiff breeze and the water considerably roughened. As this auxiliary power is intended mainly to be applied in those latitudes where dead calms prevail for days, and sometimes even weeks at a stretch, there can be little doubt of the utility of Mr. Duncan's invention if it is proved to be successful on the long sea voyage.

LAUNCH OF THE "VINE" AT GOVAN.

On the 31st of August, Messrs. Randolph, Elder, and Co. launched from their shipbuilding yard at Fairfield, Govan, the *Vine*, a screw steamship of 662 tons builders' measurement, and 100 horse-power (nominal), of the following dimensions:—Length over all, 190ft.; breadth 26ft. 9in.; and depth (moulded), 18ft. The *Vine* has been built to the order of D. R. M'Gregor, Esq., of Leith, and is intended for the Continentral trade. Her engines, which are being supplied by the same firm, are on their combined principle of high and low pressure, now so well known to all readers of the ARTIZAN.

LAUNCH OF THE "CUYABA" AT GREENOCK.

On the 31 August, Messrs. Robertson and Co. launched from their yard a new iron paddle saloon steamer, named the *Cuyaba*, for A. J. dos Santos, Esq., Monte Video, of the following dimensions :—Length on load line, 186ft.; breadth, moulded, 24ft. (and sponsed 1 foot on each side, making actual breadth of hull 26ft.; depth of hold to main deck, 8½ft.; ditto to spar deck, 15½ft.; tonnage about 500 tons register. The vessel was taken direct to Glasgow to receive her machinery, which has been made by Mr. David Rowan, consisting of a pair of oscillating engines of 110 horse-power, nominal, supplied with all the latest improvements.

TRIAL TRIP OF THE "EUROPA."

The new transatlantic steam-ship *Europa*, recently launched from the building yard of Messrs. Alex. Stephen and Sons, Kelvinhaugh, as an addition to Messrs. Handyside and Henderson's Anchor Line, had a very satisfactory trial of her machinery on Saturday, the 14th inst.; running the Lights and measured mile distances at a speed equal to eleven nautical or thirteen statute miles per hour, and performing all the ordinary evolutions with unusual celerity and exactitude. The trip extended from the Tail of the Bank, off Greenock, to Pladder and back.

The *Europa* started on her maiden trip for New York on the 25th ult., under the command of Captain James Craig, senior Commander and Commodore of the Anchor.

LAUNCH OF THE "PARAGUACU" AT GOVAN.

There was launched, on the 14th ult, from the yard of the London and Glasgow Engineering and Shipbuilding Company at Govan, a fine iron paddle-wheel steamer, named as above, for the Bahia Steam Navigation Company. The *Paraguaçu* is of the following dimensions, viz.:—length on deck, 130ft.; breadth of beam, 18ft. 8in.; depth of hold, 11ft. 4in. She is to be fitted with a pair of 60-horse power engines, nominal. Diameter of cylinders, 29in.; length of stroke, 3ft.; diameter of paddle-wheel, 13ft. 8in.; length of floats, of which there are 12 to each wheel. 6ft.; she will have one tubular boiler with three furnaces.

The hull throughout its construction has been especially designed for service in the tropics, with houses on deck containing spacious saloons, &c. She will take her departure for Bahia in a few weeks. The same firm has also just completed another iron paddle steamer and six barges for the above company for service on the Alagoas Lakes, which are constructed to draw only 21 inches of water when loaded with goods and passengers. In connection with these boats there is a tramway, the cars and goods vans for which have been built by Messrs. George Starbuck and Co., of Birkenhead. The whole of the above works have been constructed from the designs and under the superintendence of Messrs. Thompson and Noble, consulting engineers, Liverpool, the senior of which firm has also designed and superintended the construction of all the steam vessels built for this company for more than nine years past.

AUXILIARY POWER TO SAILING VESSELS.

The Cunard paddle steam ship *Niagara*, having been converted, by Mr. Robert Duncan, shipbuilder of Port Glasgow, to a full rigged sailing vessel of 1,600 tons register, he has applied to it an invention recently patented by him, with the view of overcoming the very considerable loss of time to sailing ships, on account of the calms which prevail in certain latitudes. Means for overcoming this have, for a long period been engaging the attention of many nautical and scientific minds, but as yet nothing of a satisfactory nature has been devised to overcome the obstacle, as it is well known in the case of steamers that so much space is taken up with machinery, boilers, and fuel, that little room remains for sufficient cargo to make it pay. At the same time it is also a fact that in the case of many of our fast-sailing clippers, could these calms be got through at a moderate speed, their passages would be considerably lessened, and the voyage made in a time little short of the steamer, with considerable less expense, and at the same time with a larger cargo.

Mr. Duncan's invention consists in passing the steam from the boilers on deck (which are used for condensing, working the pump, winches, and windlass, &c, as in any modern vessel) to one of the ships boats which is lowered alongside, and is provided with an engine and screw propeller, and which is made fast, guyed out from the ship's side. It is expected, with this appliance, that a ship of such size will be towed about four knots an hour in a calm, with a consumption of fuel of about four tons per day. The machinery of this boat, of course, takes nothing from the carrying capacity of the ship, as she only occupies her usual space on deck during the voyage, and the coal is not much as a matter of dead weight. The whole machinery and coal for ten day's steaming will not add more than three inches to her draught of water.

The *Niagara* left a few days since on her first voyage to Melbourne, and her progress in her new career will be watched with considerable interest, until the result is ascertained of this practical application of Mr. Duncan's invention, which we consider must be a very valuable auxilium to sailing vessels. We give, in another column, the result of a trial of the *Niagara*.

TRIAL TRIP OF THE "ONYX."

The twin screw steamer *Onyx*, the launch of which appeared in our last, had her trial trip on the 13th ult, when, notwithstanding the unfavourable state of the weather the trial, both as to speed, the working of the engines, and the general performance of the vessel, was very satisfactory. The engines of the *Onyx* are on the high and low pressure principle, and it is intended to work them with a pressure of 60 lbs. per square inch. It was found on the trial that the boilers were sufficient to supply abundance of steam at that pressure. After the trial the *Onyx* was taken up the river to load for her voyage to Monte Video.

LAUNCH OF THE "ANNIE MAIN," AT KELVINHAUGH.

Messrs Alexander Stephen and Sons, launched on the 16th ulto., from their yard at Kelvinhaugh, an iron sailing barque named the *Annie Main* of 550 tons, and A A 1 at Lloyds.

LAUNCH OF THE ARDGOWAN AT GREENOCK.

Messrs. Steele and Co., launched, on the 19th ult., a fine ship of about 1,300 tons, named the *Ardgowan*, owned, we understand, by Messrs Hamilton and Adams, Greenock, and is to be employed in the East India trade.

LAUNCH OF THE "SILVER RIVER," AT RUTHERGLEN.

Messrs. Seath and Cormell have launched from their yard at Rutherglen, a handsome screw steamer, 441 tons register, intended for foreign service. She has two decks, her engines, surface condensers, &c., will be in accordance with the latest improvements, and she is expected to attain a high rate of speed.

LAUNCH OF THE "BLACK PRINCE," AT GOVAN.

Messrs. Dobie and Co., launched on the 16th ulto., from their yard at Govan, an iron paddle steamer, named the *Black Prince*, of about 300 tons and 90-horse power, the property of Messrs. Griffiths, Bros. and Co., Liverpool. Immediately after the launch the vessel was towed down river to receive her engines which have been made by Messrs. Rankin and Blackmore of Greenock.

LAUNCH OF THE "LEANDER," WHITEINCH.

Mr. J. G. Laurie, launched on the 14th ulto., from his yard at Whiteinch, a China clipper of the first class, named the *Leander*; she is the property of F. Somes, Esq., of London, and is built on the composite principle, her dimensions being length, between perpendiculars, 210 feet; breadth of beam, 35ft. 2in.: and depth of hold, 20ft. 8½in.

LAUNCH OF THE "GREATA." AT WHITEINCH.

Messrs. Barclay, Curle and Co., have launched from their yard at Whiteinch, an iron screw steamer of 600 tons register, for the Carron Company's line of packets between London and Grangemouth. The *Greata*, as the vessel is named, will be fitted with engines of 120-horse power, nominal also by Messrs. Barclay, Curle and Co. The *Greata* is similar to the other steamers constructed by this firm for the same line.

LAUNCH OF THE "HELEN BURNS" AT PORT GLASGOW.

Messrs. Robert Duncan and Co. launched, on the 5th ult., from their building yard, a finely modelled iron ship, named the *Helen Burns*, of the following dimensions, viz.:—Registered tonnage, 800; length, 185ft.; breadth, 32ft.; and depth of hold, 19ft., 9in. The ship is owned by the Albion Shipping Company, of which Messrs. Patrick Henderson and Co. are the representatives. She is the third vessel of similar tonnage built by Messrs. Robert Duncan and Co. for the Albion Shipping Company, her predecessors being the *Helen Denny*, and *Elizabeth Fleming*. A fourth ship is in course of construction in the yard of Messrs. Duncan for the same owners. The *Helen Burns* will be employed in the Rangoon and Moulmain trade.

RECENT SHIPBUILDING CONTRACTS.

We understand that Messrs. Robert Steele and Co., of Greenock, have contracted to build a new iron ship of about 1,200 tons for Messrs. R. Shankland and Co., as a sister ship to the *Janet Cowan*, and intended for the East India trade. Messrs. Steele and Co. have also contracted to build an iron ship of about 1,000 tons for Messrs. Baine and Johnston, intended for the East India trade.

TOTAL NUMBER OF VESSELS LAUNCHED ON THE CLYDE DURING THE MONTH OF AUGUST.

The total number of vessels launched on the Clyde during the month of August was twenty-one. The tonnage of three out of the eighteen vessels has not reached us; that of the remaining eighteen is 12,003 tons. Of the twenty-one vessels fifteen were steamers, all of iron, including two steam ferry boats for the Clyde, eleven screws, and three paddle steamers. Three only of the twenty-one vessels were sailing ships, and these were all iron built.

The following is a copy of the recently published tabulated statement of the tonnage of sailing and steam vessels which arrived in the harbour of Glasgow, viz., for sailing vessels, from January 1862 to June 1867, inclusive; and for steam vessels, for the last three years, inclusive, up to June of present year:—

Sailing Vessels.

	1862.	1863.	1864.	1895.	1866.	1867.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
January	45,362	33,107	35,628	26,846	30,731	24,516
February	27,241	29,244	33,078	31,356	27,645	30,996
March	32,475	39,328	33,945	40,069	37,968	34,532
1st quarter	105,258	101,679	102,651	97,271	96,344	90,044
April	40,792	37,273	35,390	32,026	31,639	42,642
May	36,992	30,593	31,433	43,077	44,661	39,224
June	36,936	42,381	45,594	32,155	38,174	35,225
2nd quarter	114,720	110,247	112,417	107,258	114,474	117,091
July	51,637	44,197	40,742	48,736	39,301	
August	46,658	50,970	48,523	45,840	46,265	
September	47,918	51,804	42,737	40,126	35,219	
3rd quarter	146,213	146,971	132,002	124,702	120,785	
October	55,002	41,708	42,872	41,133	43,648	
November	40,590	42,905	43,089	39,536	41,052	
December	38,066	34,122	34,282	37,547	35,799	
4th quarter	133,658	118,735	120,143	118,216	120,499	
Total tons	499,848	477,632	467,213	445,447	552,102	

Steam Vessels.

The number and tonnage of sailing vessels is far exceeded, as will be seen from the subjoined table, by that of the steam vessels. The decrease this year on the tonnage and number of arrivals, as shown by the annexed table, is to be accounted for, first, by the change in the measurement, and second, by the withdrawal of the Dumbarton steamers, which when they ran entered into our harbour four and five times each day. To show the effect which the new system of measurement has had on the tonnage it may be stated that some of the American liners have been reduced between 100 and 200 tons. The following is the number of arrivals, and amount of tonnage for the last three years:—

	1864-65.		1865-66.		1866-67.	
	No. of Arrivals.	Tonnage.	No. of Arrivals.	Tonnage.	No. of Arrivals.	Tonnage.
July	1,178	122,757	1,363	144,847	1,339	148,462
Aug.	1,307	132,514	1,410	148,237	1,396	151,902
Sept.	1,168	123,724	1,258	133,864	1,212	133,844
Oct.	946	102,566	1,079	118,838	994	112,336
Nov.	777	93,504	802	96,482	811	102,858
Dec.	784	85,466	824	100,209	786	89,767
Jan.	712	78,324	733	89,597	575	81,446
Feb.	680	72,185	653	76,923	596	77,178
Mar.	818	87,918	953	101,419	678	90,754
April	1,012	106,340	930	105,515	868	101,773
May	1,226	122,330	1,291	136,831	996	115,259
June	1,248	133,593	1,316	147,702	1,182	128,874
Total	11,856	1,261,284	12,612	1,400,464	11,433	1,334,453

Shipbuilding at Montrose.

The first iron vessel built at Montrose was launched on the 30th of August from the yard of Messrs. Joseph Birnie and Co. The vessel is a fine schooner. The *Precursor*, as she is very significantly named, is 142 tons register, and is intended for the Baltic trade. She is owned, we understood, by Provost Mitchell. Her builders are about to lay down another iron vessel immediately, and they have at present on the stocks two large composite vessels.

The Improvements in the City of Edinburgh.

Some few months back we devoted an article to the then projected Edinburgh improvements, the Act of Parliament for the carrying out of these has since been obtained, and the other day the Town Council of Edinburgh formed itself into a body of trustees for the purpose of carrying out the provisions of the Act. The Lord Provost, who presided, stated that nothing could be done in the way of purchasing property under the Act until November; but he might say that, when they came to consider the subject, he would be disposed first to proceed with the improvement of North College-street and the street from the North British Railway Station to Leith Wynd. By showing Parliament that the town was to do what it could to improve the locality in which the Museum of Science and Art was situated, an additional argument would be given for obtaining a vote to complete the building. The other street would give sites for Trinity College Church and other buildings and houses which were in demaud. Several members gave expression to similar sentiments to those which had fallen from the Lord Provost, while others urged that it would be better to proceed first with the localities most requiring to be cleared out in consequence of the high death-rate existing in them. No definite resolution on the matter was, however, adopted.

SUGAR.

Since we adverted to this subject in former numbers of The Artizan, we find it is engaging the attention, more and more, of the buyers, as well as the producers of sugar. If the revenue must have a claim on sugar, let it be so, for we can have nothing whatever to do with discussing that question here; only let the required duty be levied without paralysing enterprise, The amputating blade need not be designedly notched. For instance, can anything be more clumsy in design, or offensive to business transactions, than the perplexing duties which vary with the shade of colour.

The sugar-planter is discouraged at the outset. He produces a clean, good sugar, to be taxed here more heavily than the produce of his neighbour who has drifted into dull routine, by indifference. He may escape bankruptcy by getting into that rut himself. There is no difficulty whatever in deciding the per centage of sugar in a given mass, yet we accommodate duties to the general quality, independent of the saccharic quality. It is thus that cupidity and caprice get introduced to the annoyance of those who oppose them.

It is worthy of note, that this foul, slovenly-made sugar, is produced at a loss of more sugar than is sold. Some growers desire to avoid this serious loss of sugar, and they too make a cleaner sugar as a consequence. Success in this direction again involves the cleaner product in a heavier duty. Hesitation may thus be induced, to be too often followed by the abandonment of a thankless, profitless enterprise. Therefore, many West India plantations exist only in name.

These things are being ventilated daily by our commercial men, and by that portion of the press, which more especially consults their interests. *The Produce Markets Review* has gone very fully and ably into the subject with abundant statistics to satisfy the enquirer. Under such well directed pressure in every direction, we may hope for a change that must be beneficial to all concerned. Meanwhile, another struggle we see is made to improve the quality and the quantity of the cane-sugar produce. The dailys gave us an elaborate introduction to "the process of Mr. Knaggs." The gist of the matter here, is, the introduction of sulphurous gas into the juice. From a chymical point of view, the idea is an excellent one; from a commercial and economic point, much depends on the *how* it is done. Cyder we all know, is often treated with this same gas, but with very questionable success, when the flavour of sulphuretted hydrogen—or rotten eggs—is retained. However, it is plain that Mr. K. has been studying his subject practically, and at the proper place. As he evidently desires success, he must go on to discover an easier and less questionable process. We are perfectly aware that it is to be done. We have seen an increased product of 50 per cent., of a first class sugar, from rat-eaten canes collected after "the cutting" was finished. It was a challenge.

As Mr. Knaggs progresses, he will certainly see room for a great improvement also in our sugar mills. We enjoy a positive veneration for antiquity yet not enough to perpetuate our old style of mill, nor the old process and its knick-knacks. Experience dictates a change, and the time for these changes is fast approaching.

"Let us aid it all we can."

We perfectly agree with Mr. K. on the vile use of lime in sugar making, which is nick-named "tempering," it should be more properly tampering. It is about as outrageous as Leibig's unfortunate expression "the food of plants," which has been as heedlessly perpetuated as the Frenchman's "temper."

THE STEAMSHIP "UNION."

The following Abstract of log of S.S. *Union* (gross tonnage 2876), belonging to the Norddeutscher Lloyd, of Bremen, built and engined by Messrs. Caird and Co., of Greenock, and which left New York for Southampton, 11th July, 1867, at 3.45 p.m., will prove of interest to our readers as being a highly creditable performance worth recording. Messrs. Caird and Co. have for many years been celebrated for the success attained, by them in combining the making of excellent and economical steam machinery with the building of first-class ships.

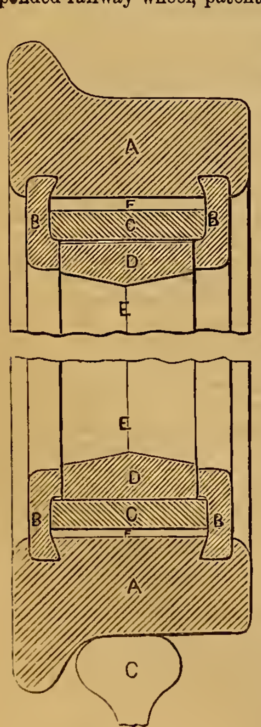
-	Revolutions per day.	Distance by observation.	Revolutions per minnte.	Mean Pressure in Engine-room.	Expansion.	Vacuum.	Coal per day.	Latitude.	Longitude.	Wind.
July 12	66,326	266	51·4	22	14	25	54	40° 31′	68° 4′	Free light breeze.
„ 13	73,045	316	51·8	23½	„	„	57	41 41	61 10	Beam S, do. Fog.
„ 14	73,010	342	51·78	24	13·14	„	57	42 44	53 36	Beam S, do. Fog.
„ 15	74,040	316	52·5	25	13	„	58	43 56	46 33	Beam do.
„ 16	71,889	323	51·	23	13·12	„	56	46 3	39 35	Free light brecze.
„ 17	73,160	315	51·8	24	12·13	„	57	48 29	32 44	Free, very light.
„ 18	73,710	319	52·4	24	13	„	57½	49 38	24 47	N. Beam, do.
„ 19	73,350	306	52.	24	13	24	57½	49 5	16 55	Calm, and on bow do.
„ 20	73,170	342	52·	24	13	23	57	49 12	8 10	Beam. Fresh breeze.
„ 21	60,090	270		24	13	„	48	Needles	8 a.m.	Free light breeze.

Passed the Needles on 21st July, 1867, at 8 a.m. Average speed 13·72 knots.

The records of steamship performances collected by the British Association Committee, give some excellent examples of the successful voyages of numerous steamships constructed and engined by this firm, and when Messrs. Russell, Rankine, and others, appointed last year by the British Association, at Nottingham, complete their investigations in the performances of the various steamships, of which returns were published by the Steamship Committee, it is believed that those supplied by Messrs. Caird and Co., will show very satisfactorily in comparison with the performances of ships built and engined by any other Clyde, Thames, or Mersey firm.

SMITH'S PATENT RAILWAY WHEEL.

The accompanying wood-cut shows a cross section of an elastic or suspended railway wheel, patented by Mr. George Smith, jun., late of Belfast.



This wheel is designed to obviate the excessive hammering which takes place between the ordinary rigid wheels and the rails, which is such a fruitful source of wear and tear, especially at high speeds, and also to facilitate the passing over curves without sliding or skidding of the wheels and torsion of the axles. This object is effected by suspending the axle from the top of the wheel by means of an elastic steel ring, which allows for any inequality in the rail or tyre; while at the same time the tyre is free to revolve independently of the body of the wheel. The way in which this object is accomplished will be easily understood by referring to the annexed wood-cut. A, is the tyre into which one of the wrought iron flanges B is let in and welded over. C, a spring steel hoop, a little larger in diameter than the flanges on B, but less than the inside diameter of the tyre, is then put in its place. The rim of the body of the wheel D (which may be of any usual pattern), a little smaller than the hoop C, is then fitted in, and the whole held in place by the second flange B being welded in the tyre.

It will be seen that, by this arrangement, the weight of the carriage and body of the wheel D is borne by the steel hoop C, which in its turn is suspended from the top of the wheel by the flanges B, B. Thus, any irregularities in the road are compensated for by the play of the steel spring C in the space F, while the tyre is free to revolve independently of the wheel D.

We understand that a truck fitted with these wheels has been running for some time on the North London Railway, and also another on the Great Western Railway, and have given general satisfaction.

OPENING OF THE BARROW DOCKS.

The introduction of the Bessemer process for making steel has raised the little hamlet of Barrow-in-Furness to a town of 20,000 inhabitants, and there is every prospect, from its geographical position and rising importance, that this number will be doubled in a comparatively short time. The rapidity with which the town has been developed is entirely owing to the existence of the hematite iron mines in the neighbourhood, and no iron in the world is so pure and suitable for the Bessemer process as the Barrow hematite.

The value of this particular sort of ore has risen high in the market, and as a natural consequence Barrow soon saw the commencement of the magnificent Hematite Steel Works, where the furnaces are for ever roaring and flaming all the days and all the nights of the week. To these works the great firm of Messrs. Schneider, Hannay, and Co. transferred their iron works. The buildings, already far larger than any others in the kingdom, are yet not more than half the size they are ultimately intended to be. The entire supply of ore comes from the company's mines at Dalton, which is close by; indeed, the supply is so ample that, after furnishing the material for all the furnaces, a considerable quantity remains for exportation to Wales and elsewhere. The skilled artisans employed in the works are upwards of 1,500; and though there were six furnaces at work, which made more iron in less time than had ever been known before, or has been known since, viz., 14,000 tons in fourteen consecutive days. The total number of furnaces is eleven, two of which are constantly at work, and they turn out about 4,000 tons of pig iron a week. In another way, the marvellous increase in the business of the district generally may be traced. In 1847 the Furness Railway was opened, and 103,768 tons of iron ore were carried by it. In 1857 it had increased to 562,095 tons; in 1863 to 621,525 tons, of which 406,612 tons were sent to Barrow alone for shipment and consumption. Last year the ore raised in the district was 683,774 tons, of which 501,954 tons were manufactured at home. These few figures will sufficiently explain to our readers how and why it is that Barrow now bids fair to rise into the rank of a place in the first importance, and that it has been found necessary to construct the fine docks which were opened on the 20th of September.

The docks are constructed to accommodate an extensive trade and the largest vessels. The entrance is 60ft. wide, the depth of water maintained in the dock is 22ft., the store quays are 1½ miles in length, the water area of the dock and timber yard is 105 acres, the wharves adjoining the docks are 100 acres in extent, and warehouses, with four storeys, and a floor area of 17,000 square yards, abut on the docks. When completed, they will extend from Crow's Nest Point to Cunninger Point, and be admirably adapted for the accommodation of vessels of all sizes. Being sheltered by Walney

Island, the water will be comparatively smooth in the roughest weather. The Devonshire Dock, which is named after the Duke of Devonshire (the chairman of the Furness Railway board of directors), is 30 acres in extent, and between 40 and 50 vessels have already been brought into it for the purpose of receiving and discharging cargoes. The Buccleuch Dock has a water area of 33 acres, but it is not expected to be completed until next spring. It is also named after one of the directors—the Duke of Buccleuch and Queensberry. On what is known as Old Barrow Island, which immediately adjoins the docks, there are extensive sites for shipbuilding yards; and, from the numerous applications which have been made respecting those sites, there is every prospect that at no distant period, a satisfactory amount of business will be done in the iron shipbuilding line. Barrow will enjoy an advantage over many towns in regard to this branch of trade, inasmuch as the steel plates required for vessels may be made on the spot, by which a saving in carriage will be effected. Around the island there will be something like ten miles of sidings, and every convenience for the shipping interest as well as for the various trades to be carried on. It is thought not unlikely that, with a view of giving employment to children, a rope and a flax trade will be introduced. A very large business is also expected to be done in the timber trade. The necessary hydraulic capstans and cranes are provided on the quays. These and the engines to work them have been erected by Sir William Armstrong and Company. Extensive warehouses are being completed for the general trade, and rails are laid right up to them. As soon as the finishing stroke has been given to the work connected with the Devonshire Dock, stops will be taken to enclose the Buccleuch Dock, by forming an embankment at the Salthouse end of the port. From 1,500 to 2,000 men have been regularly employed in their formation. The engineers of this gigantic undertaking are Messrs. M'Lean and Stileman, of London; and the contractors are Messrs. Brassey and Field.

REVIEWS AND NOTICES OF NEW BOOKS.

A Treatise on the Screw Propeller, Screw Vessels and Screw Engines, as adapted for Purposes of Peace and War; with Notices of other Methods of Propulsion, Tables of the Dimensions and Performance of Screw Steamers, and Detailed Specifications of Ships and Engines. By John Bourne, C.E., author of "A Treatise on the Steam-Engine," "A Catechism of the Steam-Engine," "A Handbook of the Steam-Engine," &c. A new edition, being the third; pp. 556, with 54 plates, and 287 woodcuts. 4to. London: Longman and Co.

Although the second edition of this work was exhausted more than ten years ago, Mr. Bourne states that he has been unwilling to issue the Third until he had at his disposal the time necessary for its thorough revision; and as it is only within the last two years that he has been able to command this leisure, the design has necessarily until now remained in abeyance. The revision, however, which the work has at length undergone is so complete as to have rendered it substantially a new one; and the volume has grown in dimensions in the process of improvement until it is now twice the size that it was at first. Among other amplifications, the historical part has been continued down to the present time; and as Mr. Bourne expresses the opinion that it is not unlikely that the Screw may hereafter be superseded by other modes of propulsion, he has introduced notices of such other expedients as are either most promising or most remarkable. The progress of scientific research in connection with the screw has been described and analysed; all the chapters have been transformed and extended; a new chapter on war vessels has been added; and the appendix has been enriched by practical specifications of ships and engines, and other documents of value. Before closing the volume the author determined to add to its completeness by a full notice of the screw-propelling machinery brought together at the Paris Exhibition of 1867. With this view he has spent several months in examining the machinery collected in Paris during the present year. The latest efforts at improvement which have been made by different nations in this particular department of the arts have been examined by him, and the results are recorded in a postscript. We observe that Mr. Bourne has formed a very unfavourable opinion of the species of engine which M. Du Puy de Lôme has designed for the French Navy as he regards it as heavy, complex, bulky, and liable to the very serious objections, that if any part of any of the three engines of which the combination is composed goes wrong, the whole will be disabled, and also that there is no power of working with full steam on emergencies, so that the vessel if temporarily pressed may be able to increase her speed. M. de Lôme's arrangement consists in the combination of a single high pressure cylinder with two low pressure cylinders, and when two-thirds of the stroke of the high pressure piston has been completed, the steam is let into the low pressure cylinders and thereafter expands in the whole. There is no power of using more steam however, direct from the boiler than the high pressure cylinder measures out, and if any part of any engine is disabled so as to prevent that engine from working, the whole combination will be disabled, as the remaining engines will be unable either to receive or dispose of the steam. These are certainly enormous oversights, and it would have been much better if M. Du Puy de Lôme, instead of adventuring into the region of *improvement*, as he imagined, had accepted his proper position and rested content with imitating what had been done by more competent men elsewhere. It is likely enough that Mr. Bourne's exposure of these faults will have the effect of imposing a salutary check upon M. de Lôme's aberrations and save the French navy from being some day caught in a trap by the discovery of vital defects just at the moment its services are required. The whole design of that navy, Mr. Bourne says, is bad. The armour is too thin to be of any avail against modern ordnance, and it was a mistake to apply armour upon wooden hulls. The guns are inadequate, and the engines bad. The vessels, moreover, are too blunt to be suitable for high speeds. Our own war vessels are no doubt faulty too, but only in the hulls, and not in the engines, and there are symptoms of the Admiralty emerging from its past faults by the adoption of the Monitor system of construction—a result imputable mainly to the public discussion that for some time has been going on upon this subject. In France, however, the official mind is very much left to itself, and hence it fails to perceive fallacies which have elsewhere been exploded.

It is, of course, impossible within the narrow limits to which these remarks must be confined, that we can follow Mr. Bourne very far in the disquisitions of which this large volume is made up, and, in fact, we can do little more than indicate the principal contents of the work. In the previous editions Mr. Bourne laid down various important doctrines in connection with screw vessels, which have now been generally accepted by engineers, and are employed to regulate engineering practice. Of these, one was that ships should be built on the principle of a hollow-girder, in regard to strength, and that, consequently the deck should be strong enough to balance the bottom. Another very important doctrine, first propounded by Mr. Bourne in a former edition of this work, is that the resistance of ships is mainly produced by the friction of the bottom on the water, and he also pointed out that the water lines of a ship should be such as are produced by the action of a pendulum, or, in other words, that the progressive areas of cross-section at successive frames should follow the parabolic law now adopted in the best vessels. He further, fifteen years ago, pointed out the great importance of deeply immersing the screw in the water,—a condition since made good use of by Mr. Reed to compensate for the evil of the too great bluntness of his ships. Mr. Bourne was also the first to introduce the system of balancing the momentum of the working parts of screw engines by counterweights. In the present edition of his work he gives a new explanation of the phenomenon of negative slip. He also shows how much of the power, at present thrown away in the propulsion of vessels may be recovered and utilised, and there is little doubt that, by following his prescriptions, any desired speed may be obtained with much less power than would otherwise be necessary. Nor does he confine his elucidations to the action of the screw alone. He also treats of other modes of propulsion, some of which he believes will yet supersede the screw. He has small hopes, however, of propulsion by a jet of water, such as has been employed in the *Water Witch*.

The following are the titles of the different chapters of the work:—Historical account of the origin and progress of screw propulsion; Practical introduction of the screw propeller; Scientific principles concerned in the operation of screw vessels; Comparative efficiency of the screw and paddle as a propeller; Comparative merits of screws of different kinds; Screw vessels for purposes of commerce; Screw vessels for purposes of war; Comparison of different kinds of screw engines; Details of the construction of screw engines and ships; and Recapitulation of doctrines and conclusions.

These titles are much the same as the titles of the chapters in the former editions. But all the chapters have been greatly improved and amplified. Of the appendix the titles of the component papers are as follows:—Dimensions of screw steam vessels in her Majesty's Navy; Performance of screw steam vessels in her Majesty's navy; Explanation of tables of dimensions and performance of screw vessels; Results of experiments made with the French screw steamer *Pelican;* Account of the performance of the United States screw steamer *San Jacinto;* Screw and paddle vessels on the Atlantic; Comparison of the screw steamer *San Jacinto* and paddle steamer *Saranac;* On the introduction and progressive increase of screw propulsion in the navy; Performance of screw steamers in her Majesty's navy up to March, 1865; Armour-clad ships of France and England; French armour-plated ships; English armour-plated ships; Specification of screw steam vessel *Alma,* constructed by J. Bourne and Co.; Specification of screw steam vessel *Azof,* constructed by J. Bourne and Co.; Specification of screw steam vessel for the Peninsular and Oriental Company; Prices of screw steam vessels; Admiralty returns of dimensions and performance of war vessels; Lloyd's rules for iron steamers and iron sailing ships; Specification of engines and boilers of American war steamer *Hassalo.*

The plates, which are engraved in the first style of art are as follows:—Portraits of J. Bourne, F. P. Smith, and J. Ericsson; Comparative forms of fore bodies of steamers *Salamis* and *Helicon*; Dynamometer diagrams taken in the *Rattler;* Indicator diagrams taken in the *Rattler;*

Mangin's screw as fitted to steamer *Favourite*; Machinery of water-jet propelled steamer *Waterwitch*: Lines of screw steamers *Fairy* and *Faon*; Lines of yacht *Fire Queen*, and of *Biche* and *Sentinelle*; Lines of steamers *European* and *Frankfort*; Lines of steamers *Rattler* and *Great Britain*; Vertical and horizontal section and builder's lines of steamer *Great Eastern*; Screw steamer for navigating canals; American turret vessels *Chicksaw* and *Nauset*; Cross section of American Monitor iron-clad *Dictator*; American torpedo vessel *Spuyten Duyvel*; Engines of screw steamers *Fairy* and *Faon*; Comparative view of geared screw engines; End elevation of engines of steamer *Plumper*; Engines and boilers of screw steamer *Fire Queen*; Ground plan and end view of engines of steamer *Fire Queen*; Engines of steamers *City of Glasgow*, *City of Manchester*, and *Glasgow*; Engines of screw steamer *Correo*; Comparative view of direct-acting screw engines; Engines of American war steamer *Princeton*; Vertical and horizontal sections of after body of steamer *Pomone*; Section and plan of engines of steamer *Amphion*; Engines and boilers of screw steamer *Wasp*; Vertical and horizontal sections of after body of *Ajax*; Cross section of steamer *Great Eastern* at paddle engines; Paddle engines of steamer *Great Eastern* (perspective view); Elevation of engines of screw gunboat *Shearwater*; Engines of *Warrior*, *Black Prince*, *Achilles*, *Minotaur*, &c.; Sections and plan of engines of steamer *Agincourt*; Elevation and end view of engines of steamer *Lord Clyde*; Section and ground plan of engines of steamer *Surat*; End view of engines of Russian iron-clad *Pervenetz*; Front elevation of engines of screw steamer *Mataura*; Engines of steamers *Pereire* and *Ville de Paris*; Engines of American monitor *Monadnock*; Engines of American steamer *Hassalo*; and Engines of yacht *Kingston*, by D. Thomson.

These recapitulations will give our readers some slight idea of the more important contents of this important volume, which is substantially a new work and brings the subject up to the highest point of development it has yet attained.

L' Indispensabile (*pel commerico*) *Rivista mensile legale-commerciale del Regno d' Italia, &c.* The "Indispensabile" journal of commerce, a monthly review of commerce and jurisprudence, devoted to the protection and recording the progress of the trading interest in the kingdom of Italy. Edited by Augusto Lossa. Turin, 1867. Vol. i., Nos. 1 and 2.

During the seven years that have elapsed since the amalgamation of the various kingdoms and duchies of Italy into one commonwealth, public works, commerce, and industry theretofore hemmed in and neutralised by interior custom barriers, and by the narrow-minded commercial policy of the former governments, have advanced and developed themselves rapidly throughout the peninsula, owing chiefly to the general adoption of the free-trade system, to a limited extent, which was first inaugurated by the Piedmont, and successively extended over the United Kingdom. In none of the countries of Continental Europe a knowledge of the importance of the freedom of commerce and labour, first systematised by Adam Smith, and subsequently carried through in Great Britain, by the strenuous efforts of Cobden, Peel, Gladstone, and others, has been so consistently propagated, and so successfully established as in United Italy. The restrictions imposed by the former sectional governments upon foreign commerce, by means of onerous protective duties, having now all but vanished, and a rational, strictly *fiscal* tariff having been substituted therefore, the condition of public works, commerce, and industry, throughout the peninsula is rapidly improving, and promises to become still more flourishing, as soon as the final consolidation of the whole territory be effected, the present paper currency done away with, and thorough good faith practised towards foreigners employing capital and talent in Italy.

Hitherto, the interests of commerce in Italy have been represented only by the political daily journals, and by special local organs, as the *Commercio di Genova*, *Il Corriere Mercantile*, *Il Sole*, and several others; the want of a publication devoted to these interests for the whole of the peninsula has long been felt, and is now efficiently supplied by our new contemporary, the *Indispensabile*, whose appearance we hail with much satisfaction. This journal forms a compilation of all facts and figures relating to both the interior and foreign commerce of the kingdom; it contains, in each monthly number, complete publications of concessions for public works granted or applied for to the Italian Government; lists of patents for inventions; lists of all cases of bankruptcy and compositions, reports on law cases and other proceedings connected with public works, commerce, and industry; records of all matters relating to banking, insurance, commercial, and industrial partnerships, custom duties, railways, electric telegraphs, &c.; a special department is devoted to navigation, and periodical statements of the imports and exports are promised. The *Pronti avvisi*, or "passing notices," appear in weekly supplements when necessary. Each number of the *Indispensabile* contains forty-eight closely printed octavo pages. In the two first issues we have before us, the promises given in the prospectus are fully redeemed, and we have no doubt this publication will succeed in becoming a "guide and adviser" to all persons interested in the public works, and the commerce and industry of the kingdom of Italy.

LATEST PRICES IN THE LONDON METAL MARKET.

	From			To		
	£	s.	d.	£	s.	d.
COPPER.						
Best selected, per ton	84	0	0	85	0	0
Tough cake and tile do.	80	0	0	81	0	0
Sheathing and sheets do.	81	0	0	83	0	0
Bolts do.	83	0	0	,,	,,	,,
Bottoms do.	85	0	0	,,	,,	,,
Old (exchange) do.	72	0	0	,,	,,	,,
Burra Burra do.	85	0	0	86	0	0
Wire, per lb.	0	1	0	,,	1	0½
Tubes do.	0	0	11½	0	1	0
BRASS.						
Sheets, per lb.	0	0	9	0	0	10
Wire do.	0	0	8½	0	0	9½
Tubes do.	0	0	10½	,,	,,	11
Yellow metal sheath do.	0	0	7¼	0	0	,,
Sheets do.	0	0	7	,,	,,	,,
SPELTER.						
Foreign on the spot, per ton	21	7	6	,,	,,	,,
Do. to arrive	21	7	0	21	10	0
ZINC.						
In sheets, per ton	27	0	0	,,	,,	,,
TIN.						
English blocks, per ton	93	0	0	,,	,,	,,
Do. bars (in barrels) do.	94	0	0	,,	,,	,,
Do. refined do.	96	0	0	,,	,,	,,
Banca do.	94	0	0	,,	,,	,,
Straits do.	90	0	0	91	0	0
TIN PLATES.*						
IC. charcoal, 1st quality, per box	1	7	6	1	9	6
IX. do. 1st quality do.	1	13	6	1	15	6
IC. do. 2nd quality do.	1	5	6	1	7	6
IX. do. 2nd quality do.	1	11	6	1	13	6
IC. Coke do.	1	3	6	1	4	6
IX. do. do	1	9	6	1	10	6
Canada plates, per ton	13	10	0	,,	,,	,,
Do. at works do.	12	10	0	,,	,,	,,
IRON.						
Bars, Welsh, in London, per ton	6	10	0	,,	,,	,,
Do. to arrive do.	6	10	0	,,	,,	,,
Nail rods do.	7	0	0	7	10	0
Stafford in London do.	7	10	0	8	10	0
Bars do. do.	7	10	0	9	10	0
Hoops do. do.	8	10	0	9	12	6
Sheets, single, do.	9	5	0	10	0	0
Pig No. 1 in Wales do.	3	15	0	4	5	0
Refined metal do.	4	0	0	5	0	0
Bars, common, do.	5	15	0	6	0	0
Do. mrch. Tyne or Tees do.	6	10	0	,,	,,	,,
Do. railway, in Wales, do.	5	10	0	6	0	0
Do. Swedish in London do.	10	5	0	10	10	0
To arrive do.	10	5	0	,,	,,	,,
Pig No. 1 in Clyde do.	2	15	3	3	3	2
Do. f.o.b. Tyne or Tees do.	2	9	6	,,	,,	,,
Do. No. 3 and 4 f.o.b. do.	2	6	6	2	7	0
Railway chairs do.	5	10	0	5	15	0
Do. spikes do.	11	0	0	12	0	0
Indian charcoal pig in London do.	7	0	0	7	10	0
STEEL.						
Swedish in kegs (rolled), per ton	14	5	0	,,	,,	,,
Do. (hammered) do.	15	0	0	,,	,,	,,
Do. in faggots do.	16	0	0	,,	,,	,,
English spring do.	17	0	0	23	0	0
Quicksilver, per bottle	6	17	0	,,	,,	,,
LEAD.						
English pig, common, per ton	19	12	6	,,	,,	,,
Ditto. L.B. do.	20	0	0	,,	,,	,,
Do. W.B. do.	21	15	0	,,	,,	,,
Do., ordinary soft, do.†	20	0	0	,,	,,	,,
Do. sheet, do.	20	10	0	20	15	0
Do. red lead do.	20	15	0	21	5	0
Do. white do.	27	0	0	30	0	0
Do. patent shot do.	23	0	0	,,	,,	,,
Spanish do.	19	5	0	19	10	0

* At the works 1s. to 1s. 6d. per box less.
† A Derbyshire quotation, not generally known in the London market.

NOTES AND NOVELTIES.

MISCELLANEOUS.

WILSON'S NEW CENTRAL FIRE BREECH-LOADING RIFLES.—Mr. Thomas Wilson, of Birmingham, has just submitted his new breech-loading rifle, which appears the most simple, direct, and amazingly rapid action ever witnessed. The action itself consists simply of a plug sliding longitudinally in the rear of the barrel. The mere withdrawal of the plug suffices to open the breech, extract the cartridge case, and completely expel it from the chamber. On a fresh cartridge being introduced the plug is simply driven home by the hand, and thus, by two simple movements, the entire working of the action is effected, and all that is required for opening, clearing, loading, locking, and securely fixing the breech for firing is accomplished, and so rapidly and certainly are these movements performed that the rifle can be loaded and fired twenty times in one minute. The entire mechanism (except the trigger) for locking and discharging the rifle is situated in, and carried by, the moveable plug, which appears strongly and neatly made, and can be detached from the breech in a moment when required for clearing or other purposes. Another very important feature in this rifle is, in its entire freedom from cocks, levers, hinged blocks, and, in fact, every kind of projection about its rear, which makes it exceedingly smooth to handle, and at the same time greatly reduces its cost, and facilitates its complete and rapid manufacture by machinery. Mr. Wilson, we are informed, is applying the same action to his new needle or self-clearing cartridge breech-loader, which, requiring no cartridge extractor, can be made cheaper, and fired even more rapidly than his draw cartridge breech-loader just described. The self-clearing cartridge breech-loader has recently been under trial by the ordnance committee at Woolwich, and reported the most simple and rapid breech-loader yet tried. The ammunition for this gun is exceedingly simple and compact, and only half the weight and cost of the Boxer cartridge.

THE inhabitants at, and near, the Cape ot Good Hope are bestirring themselves beyond the stolidity of the Dutch Boer, and reaping the fruit of industry. At about two miles from the Town-house, a large bank of solid bitumen or petroleum has been discovered. They have sunk on it five feet from level of surface and it holds good; 100lbs. of this mineral has produced two gallons of oil. This will be a most valuable discovery if it affords a large quantity, else it is a surface indication of oil, repaying the expense of wells in the immediate locality. The American wells for this purpose are very inexpensive. A piece of 1¼in. gas pipe, drawn to a point at one end and perforated, is jumped into the ground with the assistance of a half hundred-weight, and connected with a pump when deep enough.

THE AMERICAN TUBE WELL.—A few days since a number of gentlemen assembled upon the cricket-ground of the Manchester Club, Old Trafford, to witness the sinking of a well upon a system just introduced into this country, of which Mr. Norton, Blackfriars-street, is local agent. Water was reached in five minutes from the commencement of operations, and in twenty-two minutes a depth of 10ft. had been reached, the pump had been fitted to the top of the well, and a flow of water was obtained. The well consists of an iron pipe, 1¼in. in diameter, about 12ft. long, pointed at one end and perforated with holes about 16in. up the pipe from the pointed extremity. A moveable iron clamp is fitted round the pipe, and upon the principle of pile-driving a 56lb. hollow weight is raised and allowed to drop on the clamp, thus the pipe is driven into the ground. Earth, sand, &c., at first enters the pipe through the holes, and when these are pumped out, the theory is that pebbles rest against the pipe and form a natural filter. Such a well is free from the liability common to others of receiving surface drainage, and the water obtained from it is always cold and fresh. No dirt is made in sinking the well, no accident is possible from foul air or from the falling in of the sides, and, besides the rapidity with which the well is made, its cheapness—about £5 for the completion of a well 15ft. deep—is another great recommendation. A farmer might have such a well in almost every field. When rock is reached in well-sinking of this description, the operation is more costly than we have named, if it becomes necessary to bore the rock. One of these wells to the depth of 15ft. has been sunk in the Botanical Gardens. The work was done in an hour and an excellent supply of water obtained. The inventor accompanied the Northern army in the late American War and was the means of procuring for the soldiers an unfailing water supply. He has sunk many wells in the United States, and one at Ithace, New York, is said to be 120ft. deep.

A NEW rifle musket, the invention of Messrs. Carter and Edwards, has undergone an official trial in the Woolwich Marsh, in competition with the Snider-Enfield rifle, with the following results:—The Snider rifle was fired by Lieut. Leckey, assistant-instructor of musketry to the Royal Marine division at Woolwich; the time two minutes, when 16 rounds were fired, 14 hits were made, and 34 points were obtained. Carter and Edward's rifle was fired by Sergeant Botts, 27 rounds, 24 hits, and 54 points. The object was a third-class target with a Wimbledon bull's-eye. The superiority of the Carter and Edwards' rifle over the Snider in rapidity of fire appears to be fully established, as the rifle, which is on the bolt system, cocks itself in the withdrawal of the cartridge. The lock is entirely concealed, and the weapon is fired with a needle through the centre of the bolt. Another advantage, equally important, and also an entire novelty in small arms is —that a line or party of skirmishers, in the event of their being taken prisoners, or surrounded by the enemy at a disadvantage, can, with the turn of a screw, take out the bolt and cast it away, leaving the arm as totally useless as the Armstrong field-gun without its vent-piece. For simplicity of construction it surpasses the Snider, as there are fewer springs. In fact, the only springs it contains are the main-spring of the lock and the rear-spring.

A PROPOSED plan of Mr. Mason for draining Dunbar is under the consideration of the Council of the burgh. The estimated cost is £700, which it is proposed to spread over a period of twenty years at an annual expense of some £75. It is presumed that the repayment and not the work will extend "over a period of twenty years."

STEAM SHIPPING.

The *France*, built of iron by Rayden and Son for the National Steamship Company for the passenger traffic between Liverpool and New York, was launched in June and tried at the measured mile off Liverpool on the 11th ult. She ran the mile in six minutes against the tide. Her dimensions are.—Length, 410ft.; breadth, 42ft. 3in.; depth, 32ft.; tonnage (B. M.), 3,610. Her engines are by J. Jack and Co., and of 370 nominal horse-power.

SUCH is the opposition between the two companies running steamers from Belfast to Glasgow that passengers can now make this trip for 6d.

THE CHINA TEA RACE.—The excitement in reference to this year's great ship race has perhaps been greater this season than in any former one. The first ship of the China tea fleet having arrived in the Downs on the 14th ult., from Foo-chow-foo, and that ship being the *Taeping*, there is a little excuse for the outburst of enthusiasm which has been manifested in Greenock and in Glasgow in consequence. The *Taeping* is a Greenock built clipper, of 767 tons register, the builders being Messrs. Robert Steele and Co., and the owners being Messrs. Rodger and Co., of Glasgow. The time taken to reach the London Docks, where she got berthed at three o'clock on the morning of the 15th, was 101 days, the distance being about 14,600 miles. Last year's race was won by the *Taeping*, the time then taken being 97 days; her voyage out accomplished in even less time, namely, 85 days. This year she has been beaten by only five hours, by the *Ariel*, and last year a still less time separated them. Both were built at Greenock, and both are composite vessels.

TELEGRAPHIC ENGINEERING.

A FRENCH ATLANTIC CABLE.—It was announced some time ago that the French Government had authorised an Anglo-French company to lay a telegraphic cable from Brest to the American continent. The *Patrie* says that the preliminary soundings are complete. The cable will be laid from Brest to St. Pierre Miquelon, it having been ascertained that the bottom of the ocean along that line is favourable to the design. From St. Pierre it will go along the coast of New Brunswick, and the shores of the States of Maine, New Hampshire, Massachusetts, and Connecticut. The immersion of the cable, now making in London, is to begin in May next year, and the Great Eastern is to be employed to lay it. It is hoped that a month will suffice for the work, and that in July, 1869, at latest, France and the European continent will be in direct telegraphic communication with America.

THE cable between Florida and Cuba was manufactured by Messrs. Silver and Co. It is constructed in three parts similarly composed. There are seven conducting wires, surrounded by three coats of gutta-percha, and enclosed in an outer sheathing of galvanised iron wire varying in thickness with the probable depth of immersion. The copper wire is about one hundred and seven pounds to the mile, and the gutta-percha covering is one hundred and seventy pounds to the mile. This Cuban cable is about ninety miles long, and joins Key West to Cherara westward of Havanah. The work now completed is expected to form a base for three lines of cable, thus linking the Antilles to Central and South America.

RAILWAYS.

THE Cannon-street Station is daily improving and fast getting into regular working order. The Brighton trains now run into and out of Cannon-street, calling at the South-Eastern Station at London Bridge.

THE North-Eastern Railway people are about to extend their wagon shops at West Hartlepool to satisfy their increasing requirements.

THE railway between Botzen and Innspruck, over the Brenner Alps, was opened for traffic almost simultaneously with the line over Mont Cenis. It is expected, as a consequence, that the trade of Trieste will be absorbed by Venice, and that Italy will be considerably benefitted.

THE Midland Extension into London was formally opened on the 7th ult. for goods traffic by a train conveying some officials over the line from Bedford. The goods station at Agar Town, into which the line runs, has been opened some time, and worked from the Great Northern Railway by a branch which leaves near the entrance to the Copenhagen tunnel. The passenger traffic will be brought into the Metropolis by the Great Northern until the completion of the remainder of the line into St. Pancras. This station is not expected to be finished for twelve months. The tunnel—to complete the system with the Metropolitan line—by passing under the site of the station will be ready some time before then, and passenger trains will be run to the North from the various stations on the Underground Railway before the terminus is opened.

THE Minister of Public Works, Count Miko, has published his plan for a net of railroads in Hungary and its dependencies. Buda Pesth will be the centre of the system. The main lines run to Transylvania, to Galicia, and to Fiume. There are to be also twenty-two branch lines and lines of connection between the different existing and proposed main lines. A canal is also projected to connect the Danube and the Theis which run parallel with each other, at a distance of 60 miles, for about 200 miles. Its execution will be undertaken by the newly-formed Hungarian Credit Bank.

THE Denburn Junction Railway has been inspected by Colonel Hutchinson, of the Board of Trade, who expressed himself satisfied with the whole of the works. That part of the tunnel which fell in has been carefully rebuilt. The formal opening of the line for traffic is expected to take place this day, 1st October.

DOCKS, HARBOURS, BRIDGES.

HARBOUR OF ODESSA.—The grand prize of £1,200 has been awarded by the Emperor of Russia to Sir Charles A. Hartley, C.E., and engineer-in-chief to the European Commission of the Danube, for his plans for improvements of the Harbour of Odessa. There were twenty competitors.

THE harbour at Torquay is being extended at the expense of Sir Lawrence Palk, the lord of the manor there. A pier is being run out some 500ft. from the north end of the baths in a direction nearly W.N.W., and almost parallel to the existing pier. From its junction at the baths, and extending to the Victoria Parade, there will be a quay on which stores will be built for general and commercial purposes. This new pier is expected to cost from £35,000 to £40,000, and to be completed in about twelve months. Mr. J. W. Rowell is the architect, and Mr. J. Mountstephens the builder. There will be fourteen to fifteen feet of water at low tide. It is intended to keep the present harbour full or partially full, thereby obviating the complaints of smells from sea-weed, &c.

THE new floating and graving docks of Belfast are expected to be opened about the first week of this month.

THE Town Council of Irvine have granted £10,000 for the harbour works.

HAARLEM-MEER took thirteen years to drain. It was completed in 1852, and cost nearly a million sterling. This outlay has been recouped by the sale of 42,000 acres. Canals are cut to form a network over the whole space, and windmills pump the rain-fall, if it accumulates. The recovery of the Zuyder Zee is seriously looked forward to. This would throw all former undertakings into the shade. Amsterdam would then have an outlet to the German Ocean by the North Holland Canal now in progress of construction. During the past 200 years £300,000,000 have been expended for hydrographical purposes in the narrow tract of country, hardly as big as Wales and Yorkshire put together, lying between the Dollardt and the Scheldt. About a million per annum is absorbed in repairs and superintendence.

MINES, METALLURGY, &c.

THE SAFETY LAMP.—When that distinguished philosopher, Sir Humphrey Davy, discovered the fact that flame did not pass through wire gauze of a certain "make," it fortunately occurred to him that this fact might be advantageous to the miner and save men's lives. He enclosed the miners' lamp with this gauze, and the explosive gas has often entered its meshes and fired there without allowing the mischief to spread beyond. Still, accidents of great gravity recur to shake the confidence which repeated experiment invited. The ingenuity of our colliery engineers has been taxed to suggest a yet severer trial of the safety lamp, to discover its most vulnerable part or position, and to suggest the remedy. To this end we find there have been experiments going on in one of the pits of the Hetton Colliery with a variety of safety lamps; gas was conveyed from a "blower" there. Some importance has been given to the velocity with which the gas was made to impinge on the gauze or protecting material. But little importance can be attached to such results, seeing the safety lamp in the hands of the miner is not liable to such treatment. He may find himself in an explosive atmosphere, whilst it can be only the most extreme wantonness that could place "a safety" exposed to the force of "a blower." Whatever these experiments may lead to, and they are continued under every condition that the workmen can suggest, we can look back on many years of experience, when these lamps have been subjected to most severe ordeals, and, with ordinary care, they have proved to be perfectly safe in the mines.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated August 5th, 1867.

2262 J. G. Tongue—Wheeled vehicles
2263 G. Schneider—Breech loading firearms
2264 J. Heaton—Blast furnaces
2265 W. Prangley—Athletic exercises
2266 J. Lockwood—Furnaces

Dated August 6th, 1867.

2267 T. Whittaker and M. Rourke—Preparation of waterproof paper
2268 J. Bolland—Furnaces
2269 A. M. Clark—Reeds for weaving
2270 T. Luthringer—Colouring matter
2271 E. J. W. Parnacott—Construction of trenail
2272 H. H. Murdoch—Means for sorting, &c.
2273 F. Ryland—Pulleys for suspending window frames, &c.
2274 M. Jones—Kitchen ranges

Dated August 7th, 1867.

2275 E. Cornely—Sewing machines
2276 C. McDermott—An eyelet and paper fastener combined
2277 A. J. Paterson—Cartridges and firearms
2278 F. C. Marshall and H. Stewart—Raising water, &c.
2279 R. H. Michell—Dredging machinery, &c.
2280 M. Hamer—Indiarubber thread cutting
2281 T. S. Cressey and J. Webb—Shrinking cloth
2282 E. T. Horsley—Treating cast iron
2283 J. P. Binns—Paper bags

Dated August 8th, 1867.

2284 G. Holcroft and and W. N. Dack—Steam engines
2285 A. M. Clark—Metallic alloy
2286 C. Benson and J. Barker—Preparing moulds for the casting of pipes, &c.
2287 H. W. Withers—Construction of boats
2288 F. Wirth—Stamping letters
2289 J. E. F. Ludeke—Obtaining motive power
2290 W. R. Lake—Printing presses

Dated August 9th, 1867.

2291 T. J. Baker—Manufacture of wheat and other grain into flour
2292 W. R. Dawson—Smelting titaniferous iron sands
2293 F. J. Seymour—Case for holding cord
2294 H. A. Avery and G. Penabert—Vegetable powder for removing and preventing incrustation in boilers
2295 W. J. Miller—Table knives and forks
2296 R. Westfield—Cut nails
2297 C. Hohgrefe—Chimney tops

Dated August 10th, 1867.

2298 H. A. Bonneville—Stringed instruments having sound boards
2299 H. B. Barlow—Doubling and winding machines
2300 J. Davenport and J. Kitson—Improvements in slide valves
2301 E. Newby—Joining links
2302 G. Hodgson—Looms for weaving
2303 A. M. Clark—Refrigerating apparatus
2304 G. Warsop—Cleaning windows
2305 R. Girdwood—Composition to be applied to sheep, &c.
2306 R. Edmondson—Pickers used in looms for weaving
2307 F. H. Holmes—Production of the electric light

Dated August 12th, 1867.

2308 C. D. Abel—Removing sulphur, &c., from metals
2309 E. Mounier—Penholders
2310 E. Courtin—Splitting and cutting sarsaparilla
2311 A. Turner and W. Helmsley—Gloves, &c.
2312 J. H. Evers—Generating steam
2313 E. B. Wilson—Furnaces
2314 A. McDougall—Extraction and separation of sulphur
2315 J. Shanks and J. Cargill—Lawn mowing machines
2316 J. J. Rawlings and H. Wilkerson—Washing coprolites
2317 W. Swenson and J. E. Heilmann—Securing and holding railway tickets and labels
2318 W. T. Eley—Rendering cartridges or cartridge cases for firearms waterproof

Dated August 13th, 1867.

2319 G. Davies—Washing sugar
2320 H. T. Everist—Manufacture of gas
2321 E. Score—Quoins
2322 J. J. Bright—Actuating propellors for navigable vessels
2323 G. Pilling, J. Pilling, and F. Jennings—Covering the edges of fabrics
2324 B. F. Sturtevant—Blowers for furnaces
2325 H. M. Mellor—Circular knitting frames
2326 S. R. Wybrants—Utilising certain waste materials
2327 A. Swan—Recovering lees
2328 M. F. Halliday—Breech-loading firearms
2329 J. Badger—Cooking ranges
2330 C. E. Flower—Cooling brewers' worts and beer
2331 J. Fawcett—Extracting oils
2332 T. Walker—Cutting grooves
2333 W. Turney and J. Ackroyd—Jacquard machinery

Dated August 14th, 1867.

2334 W. B. Leachman and J. Halroyd—Pumping fluids
2335 A. M. Clark—Fastenings for bayonets on firearms
2336 C. Holliday—Printing material
2337 J. A. Jones, R. Howson, and J. Gjers—Furnaces
2338 C. F. Bower—Combined bed, couch, and chair
2339 W. Betts—Metallic capsules
2340 W. Betts—Metallic capsules
2341 G. Buxton and S. Brun—Axles of engines
2342 A. W. Williamson—Lamps
2343 H. Bessemer—Ordnance and machinery
2344 J. T. Way—Treating phosphate of lime

Dated August 15th, 1867.

2345 J. Pescock—Cleaning casks
2346 F. H. Wenham—Heated air engines
2347 T. Bushby—Pill-making machines
2348 J. Cosgrave—Heating bakers' ovens
2349 R. Cleland and R. Cunningham—Woven fabrics
2350 E. Ormerod—Safety apparatus
2351 A. F. Baird—Earth closet
2352 H. Bodart and A. Sigodart—Propelling vessels
2353 W. R. Lake—Metal ties or bands

Dated August 16th, 1867.

2354 G. Clarke—Fire escapes
2355 J. Day and W. Dorlier—Cabs, &c.
2356 M. Henry—Treating certain vegetable substances
2357 H. Franlenburg and S. Phillips—Fastening
2358 R. Joseph—Corsets
2359 T. Jackson—Pianoforte actions
2360 J. W. Dudley—Cutting corks

Dated August 17th, 1867.

2361 J. Wavish—Heating of greenhouses
2362 A. Leveson—Coverings for vehicles
2363 L. Avoyne Bainée and M. J. Sibillat—Metal spring mattresses
2364 A. Lees and W. H. Rhodes—Spinning and doubling cotton, &c.
2365 T. Sagar and T. Richmond—Looms for weaving
2366 J. Holroyd and W. Fieldhouse—Twisting yarns in mule spinning machinery
2367 M. Frow—Reaping machines
2368 A. M. Clark—Construction of moulds
2369 J. W. Dixon and W. Buttery—Closing cartridges for breech loading firearms
2370 F. B. Houghton—Treating products
2371 W. W. Pocock—Indexes
2372 M. Cohen—Sealing papers
2373 W. R. Goulty—Preparing vegetable substances

Dated August 19th, 1867.

2374 T. Tunstill—Preparing size for worp
2375 J. Cronier—Rotary heel for boots and shoes
2376 W. B. Adams—Uniting and treating iron
2377 J. Hooker and F. Braby—Fire lighters
2378 C. E. Brooman—Ornamenting fabrics
2379 W. E. Newton—Crank motions
2380 F. Parkes and G. Parkes—Spades and shovels
2381 C. Reisert—Railway carriages
2382 E. A. Cowper—Construction of safes

Dated August 20th, 1867.

2383 A. Martin—Uniting the brims to hat shapes
2384 W. Barrow—Improved rack
2385 W. Dixon—Preservation of life from fire
2386 H. Cridland—Removing the hair from the skins of animals
2387 A. S. Stocker—Bottles
2388 A. Cohen—Watches

Dated August 21st, 1867.

2389 J. Murgatroyd—Steam boilers
2390 W. Bostock—Spools, &c.
2391 C. E. Hall—Hoeing
2392 W. Thomas—Registering the number of passengers carried in omnibuses
2393 J. Robinson and J. Smith—Applying motive power to saw frames
2394 G. Luyckx—Waterproof tubes
2395 C. W. Siemens—Furnaces
2396 J. Sainty—Hurdles, &c.
2397 J. Goucher—Apparatus for preserving life in water, &c.
2398 J. M. Napier—Coining presses
2399 J. Mangnall—Elastic mattresses
2400 T. Widdowson—Umbrellas and parasols

Dated August 22nd, 1867.

2401 A. Smalley, B. Crossdale, and W. L. L. Leover—Looms for weaving
2402 T. Sault—Slide valves
2403 J. Newark—Breech loading firearms
2404 S. Lyues—Self-acting lubricator
2405 R. King, J. Lowden, and W. Gartside—Carding
2406 W. Newsome—Forming metal joints
2407 D. Howard—Fabrics termed union flannels
2408 A. M. Clark—Raising liquids by steam power
2409 J. Jones and F. J. Jones—Breech loading firearms
2410 J. G. Marshall—Solvent processes
2411 H. Higgins and T. S. Whitworth—Preparing cotton
2412 T. W. Lawson—Ships and vessels
2413 J. McIntyre—Covering and protecting iron plates from the action of sea water
2414 J. L. Norton and G. Hawksley—Burning combustible liquids, &c.

Dated August 23rd, 1867.

2415 F. Ziffer and W. Goodbrand—Warming carriages
2416 D. Whittaker—Healds used in looms for weaving
2417 H. A. Bonneville—Self-acting cooking apparatus
2418 D. Taylor—Stopping bottles, &c.
2419 W. S. Ashton—Metallic packing
2420 W. R. Lake—Iron and steel
2421 E. A. Dann—Concussion fuses
2422 J. Varley—Raising, supplying, and measuring water to steam boilers

Dated August 24th, 1867.

2423 G. Allibon and E. Wilson—Gearing for steering ships
2424 J. Cash and J. Cash—Towels
2425 A. Wigzell and E. Wigzell—Juckes' furnace
2426 J. P. Smith—Mode of draining, &c.
2427 J. Hanson—Spacing and digging roots
2428 M. Samuelson—Sewing machines
2429 W. E. Newton—Fastening for paper bags
2430 H. Davey and D. Davy—Feeding water to steam boilers, &c.
2431 W. R. Lake—Cartridges for breech-loading firearms
2432 P. Kniaghininsky, P. Galahoff, and N. Ossipoff—Setting up and distributing printing types
2433 F. J. Cleaver—Screw presses, &c.
2434 W. Berry—Removing rubbish

Dated August 26th, 1867.

2435 W. C. Thurgar—Regulating the supply of gas to burners
2436 E. Sonstadt—Treatment of seaweed
2437 W. R. Lake—A new green colour

Dated August 27th, 1867.

2438 G. Haseltine—Iron and steel
2439 W. Muir—Stitching and uniting fabrics
2440 J. W. Webb—Reefing topsails from the deck
2441 W. E. Gedge—An improved machine called a crusher
2442 E. B. Bigelow—Jacquard power looms
2443 J. A. A. Etaix—Hand screw propellers
2444 M. A. Soul—Fastening iron bands on bales

Dated August 28th, 1867.

2445 T. Sagar and T. Richmond—Looms for weaving
2446 H. Hauson—Finishing cotton
2447 J. E. Boyce and R. Harrington—Umbrellas and parasols
2448 W. Wilson and J. Cowburn—Looms for weaving
2449 G. G. Tandy—Preparation of vulcanisable compounds
2450 W. Pedder—Brushes
2451 J. Elliott—Cutting coal, &c.
2452 J. H. Johnson—Aëration of fresh water
2453 J. Storey, W. E. Bickerdike, and W. V. Wilson—Bronzing surfaces
2454 W. T. Watts and D. J. Fleetwood—Hydraulic and other presses
2455 W. B. Smith—Lever watch movements
2456 R. Edwards—Locomotive traction engines

Dated August 29th, 1867.

2457 J. Macintosh and W. Boggett—Springs for boots and shoes
2458 C. D. Abel—Direct production of phosphorus for industrial purposes
2459 H. J. Simlick—Cigar and pipe lights
2460 A. Stewart—Textile fabrics
2461 J. Douglas—Ventilating and regulating the draft of close fire ranges
2462 C. Slagg—Application of liquid manure to land
2463 J. Dyson, G. W. Dyson, and S. Martin—Cutting up iron and steel rails, &c.
2464 J. Paulin and R. D. Paulin—Feeding paints
2465 W. Muir—Starting, propelling, and stopping railway trains, &c.
2466 A. M. Clark—Submarine exploration
2467 W. E. Newton—Steering apparatus
2468 A. Mc. Wier and M. A. Wier—Signalling and indicating apparatus
2469 W. E. Newton—Rudders

Dated August 30th, 1867.

2470 J. Silvester—Spring balances
2471 A. M. Clark—Removing and cutting the hides of animals
2472 E. Weare—Furnaces
2473 I. Dixon—Submerged propeller for navigable vessels
2474 M. Hammerstein—Cigars, &c.

Dated August 31st, 1867.

2475 A. H. Brondor—Carpet stretcher and tack driver
2476 J. A. Brown—Propelling ships, &c.
2477 W. J. Matthews—Breech loading firearms
2478 W. Aubert—Diffusing odours or perfumes
2479 A. Fenton and J. Saddlands—Fish hooks and fishing rods
2480 D. Nicoll—Electric telelegraph conductors

Dated September 2nd, 1867.

2481 E. K. Dutton—Window sash fasteners
2482 H. O. W. Cooper and E. F. Cooper—Method of watering roads
2483 R. Watson—Brakes for railway trains
2484 C. Gelsharp—Malleable iron, &c.
2485 A. V. Newton—Cutting stone
2486 H. Vallauce—Fastenings for casement windows

Dated September 3rd, 1867.

2487 C. Tessier—Regulating the feeding of pulp in paper machines
2488 W. R. Pape—Breech loading firearms
2489 A. Field and W. B. Notion—Ornamenting candles
2490 A. Leigh—Sizing and finishing woven fabrics and yarns
2491 J. McKechnie—Applying concentrated heat
2492 A. E. Gellaye—Chains, cords, &c.
2493 P. F. Lunde—Obtaining extracts from vegetable substances
2494 E. Y. Robbins—Fire grates
2495 L. N. Le Gras—Milk cans
2496 E. T. Archer—Spring mattresses
2497 A. M. Clork—Cutting, carving, and engraving upon substances

Dated September 4th, 1867.

2498 G. Smith—Ladders suitable for fire escapes, &c.
2499 G. Crane—Removing snow
2500 H. G. Graham—Heating, boiling, agitating, and raising liquids
2501 W. Weldon—Production of artificial oxides of manganese
2502 G. W. Howard—Ball cartridges
2503 F. B. Doering—Working in rock, &c.
2504 J. K. Smythies—Carrying passengers through the air by a steam bird
2505 F. H. Pattison and J. W. H. Pattison—Metal founders' blacking
2506 G. T. Bousfield—Paddle wheels for water craft
2507 J. Howard and E. T. Bousfield—Cutting corn or grass
2508 G. A. Buchholz—Hulling wheat, &c.

Dated September 5th, 1867.

2509 R. A. Jones and J. C. Hedges—Fire escapes
2510 A. C. Henderson—Appliqué embroidery
2511 W. H. Kitson—Railway wheels
2512 L. B. Pothier—Securing metal bands on bales
2513 H. Carter and G. H. Edwards—Breech loading firearms
2514 G. Cope—Pressing and shaping cigar bunches
2515 J. Ford—Securing wheels, &c.
2516 J. S. Henderson and J. Macintosh—Metallic cases
2517 G. H. Pierce—Padding for horse collars, &c.
2518 E. Bernheim, G. W. Wilson, and E. Longworth—Preparing printed warps
2519 J. B. Handyside—Railway buffer
2520 A. V. Newton—Safety valves for generators
2521 H. Garduer—Miners' safety lamps
2522 F. Versmann—Varnishes

Dated September 6th, 1867.

2523 N. Seward—Producing motive power
2524 S. Cassnu-Affording instant relief to persons afflicted with any affections of the lungs or chest
2525 T. Hodson, W. Mather, and J. Risley—Lubricating shafts
2526 W. G. Creamer—Excluding dust from railway carriages
2527 T. W. Helliwell—Looms for weaving
2528 A. M. Clark—Ships and other vessels
2529 J. G. Tangue—Mole and female attire

Dated September 7th, 1867.

2530 T. Cook—Sewing machines
2531 J. J. Hicks—Lighting gas, etc.
2532 J. Cockshoot—Carriages, etc.
2533 J. Smith—Combing fibrous substances
2534 J. B. Rogers—Projectile anchor and block
2535 J. Armstrong and E. Eccleston—Steam engines
2536 E. Hubner—Rotary steam or gas engine
2537 D. Payne—Priming machinery
2538 J. Bayley and T. Bayley—Leather
2539 B. F. Stevens—Illuminating roof and roof pavement
2540 H. Woods—Presses for extracting liquid
2541 J. Whitham—Puddling and furnaces
2542 R. W. Ewer—Winders

Dated September 9th, 1867.

2543 C. Burn—Propelling carriages
2544 E. J. C. Welch—Producing artificial ice
2545 A. Paul—Stoppers for ships' cables
2546 W. E. Gedge—Extraction of colouring matter of indigo
2547 W. R. Lake—Cartridge holder
2548 C. E. Brooman—Producing hydrogen
2549 F. Tolhausen—Disinfecting fecal and manuring matters, etc.
2550 G. Clark—Cartridges
2551 D. C. Brown—Wire heddles for loom harness
2552 J. Marsden—Looms for weaving Scotch or ingrain carpets
2553 J. Eichbaru—Furnaces for melting iron, etc.
2554 J. Turnock—Cask stands
2555 J. Medhurst—Fitting ships' rudders

Dated September 10th, 1867.

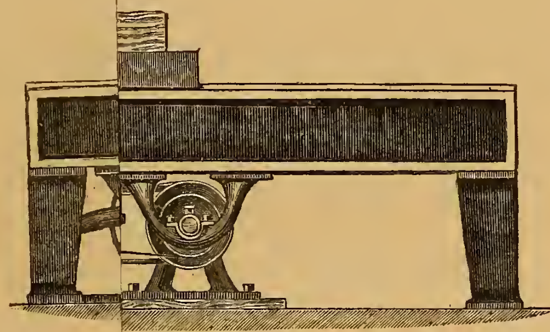
2556 J. Jurdan—Stuffing boxes, etc.
2557 C. J. Spencer and F. Ware—Steam boilers
2558 J. Dicken—Yielding fishplate
2559 J. H. Brown—Compressed leather, etc.
2560 J. Holliday—Fringes
2561 C. E. Brooman—Thermometer
2562 J. Eichbaru—Furnaces
2563 C. Sutton—Optical apparatus
2564 J. Rae—Cleansing and filtering water
2565 J. Whittome—Baling presses
2566 A. Kinton—Water wheels
2567 J. Pottle—Cucumber box

Dated September 11th, 1867.

2568 C. Mather—Washing ores, etc.
2569 E. K. Dutton and S. Mason—Bearings of hydro extractors
2570 S. Brown—Ornamenting bottles, etc.
2571 W. Baker—Iron and furnaces
2572 A. M. Clark—Polishing minerals
2573 W. Baird—Registering the number of passengers
2574 F. Weintraud—Purses
2575 J. Davies—Manufacture of salt
2576 L. M. Prewitt—Corsets
2577 H. R. Luckes—Treatment of coal, etc.
2578 W. E. Newton—Anvils
2579 W. E. Newton—Saws
2580 W. P. Cooke—Tunnelling and quarrying minerals

Dated September 12th, 1867.

2581 J. B. Meldrum—Printing textile fabrics
2582 H. Stewort—Driving the saw blade cutters of reaping machines
2583 J. Wilderspin—Horse rakes
2584 J. Perrin—Fuel economiser
2585 J. W. Hnifpenny—Tobacco pipes
2586 G. Oates—Fire escapes and ladders
2587 J. R. Cooper—Breech-loading firearms
2588 W. Brown—Rolling hoops, etc.



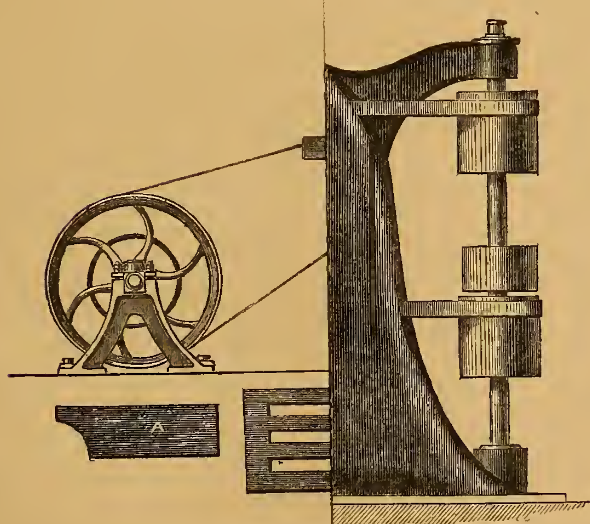
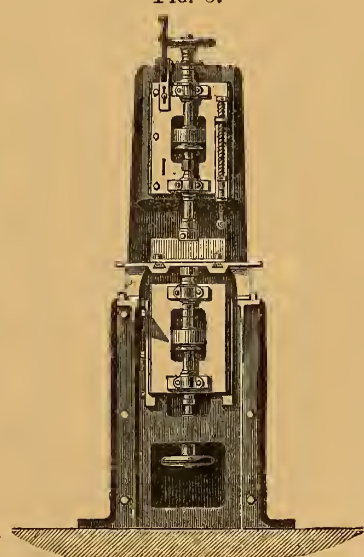


Fig. 5.



W. Smith, C.E., direx.

WOOD WORKING MACHINERY.

MACHINES FOR JOINERS' WORK BY MESSRS. S. WORSSAM & CO., CHELSEA.

Fig. 1.

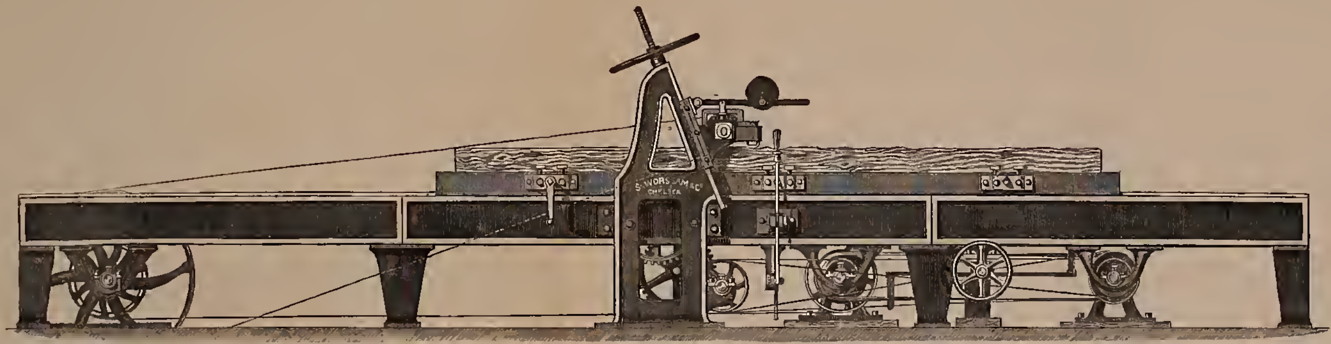


Fig. 2. Fig. 3.

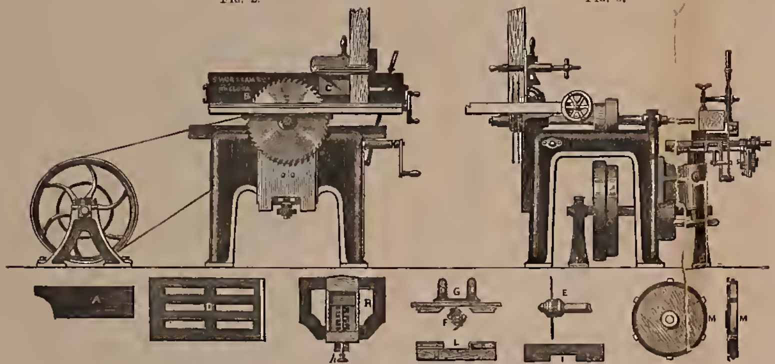


Fig. 4.

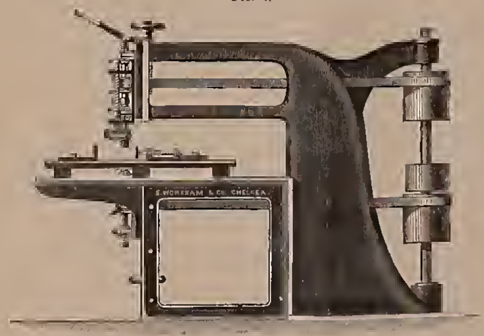
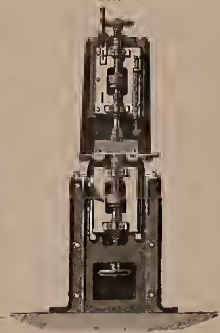


Fig. 5.



SCALE ½ INCH = 1 FOOT.

W. Smith, C.E., direx.

THE ARTIZAN.

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WOOD MACHINERY, MANUFACTURED BY Messrs. S. WORSSAM AND CO., IN THE PARIS EXHIBITION.—Class 54.

(*Illustrated by Plate* 322.)

In our last number (page 222) an account of the wood machinery in the Paris Exhibition appeared, but, in consequence of some unaccountable oversight, the most noteworthy display was passed over by the author in silence. This is even more remarkable from the fact that Messrs. Worssam's was the only display to which the jurors thought fit to award the highest prize (a silver medal) given in that department. In order to supply this deficiency, illustrations of several of the machines there exhibited are given in plate 322. The entire display, which is very complete, consists of four divisions. The first and principal of which, comprising a complete set of "labour saving" machines for joiners' work, and which are capable of performing all the different kinds of work usually done by hand in a joiner's shop—excepting only putting the work together—is especially worthy of attention, both for the ingenuity displayed and for the excellence of the workmanship. The second part consists of two cases containing samples of work turned out by these machines, as left by the tool, without being touched by hand. These specimens exhibit very clearly the nature of the work that can be executed. Many of these forms it would have been thought impossible to cut by machinery a few years ago. The third part consists of a model of a cross-cutting saw for large timber; and the last division includes models of labour-saving machines for sawing and planing stone and marble, thus forming a very complete exhibition of labour-saving machines especially useful in building. Amongst those tools which constitute the first division, may be mentioned a planing and trying-up machine (fig. 1, plate 322), which is designed to supersede the hand planes in a joiner's shop, and is especially useful for taking out of winding, and at the same time giving a planed face to, scantlings of various sizes, such as window and door frames; also cutting heavy mouldings, planing panels, and other similar work. The novelty of this machine consists in its being able to take the work out of winding and at the same time to give it a planed face fit for glueing up, without requiring to be touched with a trying plane. The scantlings to be planed are laid upon a cast iron travelling bed, and are held securely by a series of screw clamps. If the pieces are small, a number may be placed side by side upon the table so as entirely to cover it, which can thus be planed at one time. The travelling table which is planed all over is provided with a self-acting feed motion, by which the rate of advance can be varied from 6 to 15 feet per minute, according to the quality of the wood to be planed, the return speed of the table being 30 feet per minute. The machine is fitted with a simple arrangement of stops, somewhat similar to an iron planing machine, acting upon the belt-shifting gear; only, in this case, when the tool has done its work, it throws itself out of gear and stops in its original position, consequently requiring no attention.

The cutter block, which makes about 3,500 revolutions a minute, is fitted in bearings of great length and in addition to the ordinary bolts, each top bearing is provided with four small steel set-screws which are tapped into its four corners, the points of which rest upon the upper surface of the bottom brass. By the adoption of these set-screws the necessity for packing pieces between the brasses, and the constant trouble of adjusting them, is entirely avoided, while the brasses can be set to the utmost nicety, so as to make the top bearing fit close to the spindle without even so much as pressing with its own weight. Another improvement introduced into this machine, consists in making the collar outside the bearing, loose upon the spindle; the end of the cutter block spindle being screwed and fitted with two screwed collar nuts, by which the loose collar is kept up close to the end of the bearing, consequently, when the bearing wears endways the loose collar can be set up as required. It is calculated that one lad, with this machine, will do as much work in a given time as twenty skilled workmen by hand labour.

Another exceedingly useful little tool, and one which is coming into general favour, is the "General Joiner," (Figs. 2 and 3, pl. 322), in which they seem to have combined into one, as many of the various tools commonly used, as possible. This machine is adapted for sawing, planing, thicknessing, mortising, boring, grooving, tongueing, rabbetting, moulding, chamfering, and a great variety of other purposes, and seems remarkably well adapted for a small workshop.

The spindle carries a saw or cutter block at one end, and an auger or mortising tool at the other, and is provided with two tables, each having a separate rising and falling motion, so that two operations may be performed at the same time. The speed of the spindle may be varied from 1,800 to 2,600 revolutions per minute.

In Figs. 4 and 5, plate 322, are shown a front and side elevation of the "Universal moulding, shaping, and recessing machine." This is designed more particularly for moulding, shaping, grooving, and rabbetting curved and circular work, such as circular sash frames, sinking and moulding ornamental panels, and any other irregular work which is so costly to execute by hand. The chief novelty of the machine consists in its combining the operations of sinking and recessing with that of cutting circular work.

The machine is provided with two cutter spindles placed one exactly above the other; they are made of steel and are driven at the rate of 6,000 revolutions per minute, from an upright shaft at the back of the machine. For some kind of work the bottom spindle is most convenient, while for others, such as recessing, or forming a moulding in the centre of a wide piece, the top cutter is used; sometimes both may be used together. When either cutter is not required, it is raised or lowered out of the way. Each spindle is screwed on the end to take a cutter block, and bored up to take the various tools that may be required. False spindles may also be fitted into the permanent spindles for various purposes.

About the best proof that could be given of the utility of machines of this description happens to be supplied in the same building, as Messrs Trollope and Sons, are there exhibiting a magnificent sideboard, the unpolished mouldings of which remain just as they left the machine, and which appear remarkably smooth and clean.

A model of a new description of cross-cutting saw, especially designed for large timber, is exhibited by Messrs. Worssam. This appears to be a very convenient tool, as it will cut logs of timber on the ground, or it may be fixed to the end of a saw-mill where the timber enters, the saw being easily lowered down below the floor when not in use, thus leaving the entrance clear.

The models of stone-sawing and planing machines are principally noteworthy for the simplicity of their construction. They appear to be substantial, useful tools, and not so liable to derangement as the more complicated tools frequently employed.

STEAM LIFEBOATS FOR THE ABYSSINIAN EXPEDITION, BY MR. J. S. WHITE, OF COWES.

For several years past the adoption of steam lifeboats has been advocated in the columns of The Artizan, as being one of vast importance both to the navy and the mercantile marine. The great advantages possessed by such a combination must be obvious, provided those advantages are not counteracted by some inherent defect, such as excessive weight or unwieldliness. The objections to adopting steam in launches and other ship's boats have been gradually overcome, partly by reducing the weight of the machinery and the consumption of fuel to a very great extent, and partly, perhaps, in consequence of the increased size of the vessels upon which they are carried.

In The Artizan for April last an engraving was given of the engines of a steam launch for the Spanish Government, and we then took the opportunity to recommend that the boats should be built upon the lifeboat principle—not a so-called "self-righting" lifeboat, the principal advantage (?) of which seems to be its facility for turning over—but one which will not capsize or sink even when filled with a sea. A steam launch of this description was lately built by Mr. J. S. White, the well-known shipbuilder of East Cowes, for H.M. Government, and designed especially for the requirements of the Abyssinian expedition. In this boat, which is upon the system patented by Mr. John White, of West Cowes, the air chambers are carried up to the gunwale in order to get the centre of buoyancy sufficiently high, and give it a great amount of stability. The boat, engine, and boiler are required to be made as light as possible, in order that the whole may be lifted on board, or launched from a ship, without difficulty. In attaining this object Mr. White has succeeded admirably, as the total displacement of the boat at the time of trial was only seven tons, or just the weight of one of the small guns in the ship. The following are a few of the dimensions, &c., of the launch:—Length, 45ft.; beam, 9ft.; depth, 4ft. 4in.; area of midship section, 11 sq. ft.; weight of engines with steam up, 2 tons; speed (mean), 8·936 knots; revolutions of engines, 290; pressure of steam, 70lbs.; diameter of cylinder, $6\frac{1}{4}$in.; stroke of ditto, 6in.; indicated horse-power, 31.

A 30-foot pinnance, upon the same principle, has also been turned out by the same builder for the Government, in which the weight has been still further economised, while, at the same time, a high rate of speed has been attained for a boat of such small dimensions, as will be seen from the following particulars:—Length, 30ft.; beam, 7ft.; depth, 3ft. 3in.; area of midship section, 6.5ft.

	tons.	cwts.
Weight of hull	1	5
,, engines with steam up	1	0
,, coals and passengers	1	5
Load displacement on trial	3	10

Number of revolutions, 320; pressure of steam, 70lbs.; indicated horse-power, 14; speed (mean), 6·9 knots.

Besides the above boats, Mr. White has built some 27ft. and 28ft. cutters, which give nearly the same results, the weight of the hull being about 22cwt., and that of the engines, 18cwt., giving a speed of 6·8 knots, with 12 indicated horse-power.

For the use of vessels in the merchant service, or for yachts, still smaller boats have been made upon this systam, which can be hoisted on board in the ordinary manner with the greatest ease. The weight of some of these boats, as for instance, a 20ft. cutter, is only 16 cwt., including the engines and boiler with the steam up; while the speed obtained is about $5\frac{1}{2}$ knots, and they will steam forty miles with not more than $2\frac{1}{2}$ cwt. of coals.

From the above particulars it is evident that excessive weight can no longer be urged as an objection to their use while the speed at which they will travel affords in many cases peculiar advantages. The steam lifeboat launch will, doubtless, be exceedingly useful for the purpose of landing the troops upon such a coast as Abyssinia, but it is more especially advantageous in cases where opposition to such landing may be anticipated. From the peculiar principle upon which these boats are constructed, viz., Messrs. Lamb and White's patent, in which the air chambers are divided into compartments, it is almost impossible to sink them, as in the event of being struck by a shot, those compartments which remained intact would be sufficient to keep the boat afloat.

APPARATUS AND PROCESSES USED IN SPINNING AMD ROPE-MAKING, CLASS 55, IN THE PARIS EXHIBITION.

By Peter Le Neve Foster, Jun., C.E.

In this class is comprised all machinery and apparatus used in the preparation and spinning of textile materials, of which cotton, wool, flax, hemp, and silk are the most important. The materials and machinery used for ropemaking are also included in this class, together with ropes and cordage of all kinds.

From the great difference existing in the nature of textile materials, and even in their individual qualities, different modes of treatment are necessary. In cotton, for instance, the length and quality of staple varies not only in different but even in the same species.

The first process in cotton manufacture is the separation of the seed from the staple by means of gins; the next is to clean and open the bales of cotton, which arrive at the mills in a highly-compressed state. This is effected by means of scutchers and beaters, with ventilators, to free it from dust. The cotton is delivered in an even fleece, ready for the third process—that of carding—by means of which the fibres are drawn out straight and parallel, and delivered in "slivers," or hands of cotton. In some cases a combing-machine is substituted for this, and is especially adapted for the treatment of the fibres of fine numbers. In the fourth process these slivers are drawn out and doubled, in order, by the repeated mixing of the staple, to equalise their consistence and substance, and to arrange the fibres perfectly straight and parallel. In the fifth process the slivers are delivered to tne slubbing, intermediate, and roving frames; where the yarn receives the first twist, and is repeatedly drawn, doubled, and twisted, ready for the spinning operation, which finishes the extension and twisting of the yarn either in a continuous manner on the throstle, or in a discontinous manner on the mule, and finally wound upon bobbins.

Wool is of two different kinds—the long and the short staples, each of which requires a different manner of treatment in the preparation and spinning processes, as also in the treatment of the cloth after it is woven in order to fit it for the market.

The length of the fibres of long wool varies from 3in. to 8in.; this is not carded as cotton, but combed, like flax or hemp, either by hand or by machinery. Short wool is seldom more than 3in. or 4in. in length, and is carded and felted, by which proeess the filaments become first convoluted and then closely matted together. The shorter sorts of combed wool are used principally for hosiery, and the longer are manufactured into hard yarns for worsted pieces, such as waistcoats, carpets, poplins, crapes, &c.

The wool used for the manufacture of good cloth should not only be shorter but generally speaking softer and finer than the worsted wools, in order to suit it for the fulling process.

Flax machinery is required to be made much stronger than that for cotton, and it requires more power for driving it. The greater cost of flax yarns arises from the practical difficulties in converting and working the raw material.

Flax, hemp, and jute are all spun by machinery on the same principle, but with difference in size and proportions. Hemp is not only inferior in fibre to flax in softness and substance, but is more difficult to spin.

The leaves of the aloe also furnish an abundance of fibre from which ropes are made. Some excellent specimens of cordage made from this fibre are exhibited.

The machinery for the treatment of silk is extremely simple, there being no preparatory machinery required as for cotton. Silk is imported in skeins wound direct from the cocoons.

The first process is the winding of the skeins as imported off on to bobbins, and removing the irregularities and knots by passing the fibre between the edges of the cleaner, formed of two bars of steel, adjustable by screws, to pass the maximum thickness allowed, and to intercept fibres of extra thickness. It is then doubled, twisted, and reeled. These processes are called "throwing silk."

Floss silk, or "hourres de soie," consists of the shorter broken silk, which is carded and spun like cotton.

In France the principal part of the machinery used for the manufacture of cotton is made at Rouen; flax and hemp machinery, at Lisle; Alsace furnishes cotton machinery, and machinery for carding and combing wool and floss silk.

France.

One of the most important exhibitions of cotton machinery is that of Messrs. Schlumberger and Co., of Guebwiller (Haut Rhin), 19 and 51. It consists of a "breaker" carding engine with automatic stripper for "top flats," on which there are eighteen, on "Wellman's" system. The cotton is opened and cleaned by a pair of working rollers before reaching the flats. The flats are lifted out of their places for the purpose of stripping without being turned over, and a wire brush is drawn across the face of the flat to remove the fly and dust. The flat is pressed gently down upon the brush during the action of stripping. The mechanism for stripping is effected by cams, and is particularly ingenious and simple, and imitates stripping by hand.

A double carding engine, consisting of a first, or breaker cylinder, fitted with four pairs of working rollers, and the "finisher" cylinder, with ten self-stripping flats, on Wellman's plan, is shown by this firm. The doffing comb is fitted on a hollow steel axle.

The combing machine exhibited by Messrs. Schlumberger is the invention of M. Heilmann, of Mulhouse, and is especially adapted for combing cotton of fine numbers. The lap is placed on two revolving wood rollers at the top of the machine, by which it is caused to unwind and deliver a sheet of cotton down an inclined guide between fluted steel rollers, which place the cotton between the open jaws of a pair of iron nippers; the nippers then close, and by suitable cam motions are made to approach the revolving comb cylinder, where the cotton is held by them till all the short fibres and impurities are cleaned out. The combs are cleared of fly and dirt at every revolution by a cylindrical brush. As soon as the combs have passed through the cotton, the nipper recedes from the cylinder and opens, to allow the partly-combed fibres to be partially drawn out of the lap by means of a leather-covered roller, working for this purpose in contact with the fluted segment on the comb cylinder, and with fluted detaching rollers. The drawing out of these fibres causes the ends, which were previously held in the nippers, to pass between the teeth of a fine comb, and thus prevents any waste being drawn forward.

The machine is arranged in such a manner that the tuft of cotton is deposited on the detaching roller so that the ends overlap each other, and are united in a continuous sliver, to be deposited in a coiling can on one side of the machine, whilst the waste is coiled in a can on the other side. This machine is made with six deliveries, each of which produces 13½lbs. per day.

A combing machine for wool, on the same principle, is exhibited by these makers.

The slubbing and roving frames exhibited by this firm are of the usual construction.

The self-acting mule of Messrs. Schlumberger is most ingeniously arranged, and adapted for spinning fine numbers.

These makers also exhibit a set of two carding machines for wool, consisting of "scribbler" and "condenser;" these are of the usual construction, with ordinary feed lattice, &c.

The best display of wool machinery is that of M. Mercier, of Louviers (Eure) 37; it consists of both carding and combing machinery for short and long wools. Carded wools undergo the following processes:—

The burring machine, 48in. in width, is provided with Bolette's self-acting feeder, consisting of a hopper, into which the wool is thrown; at the bottom of this hopper is a travelling lattice, for the purpose of bringing the wool forward within range of the hook-shaped teeth of a vertical lattice, by means of which the wool is lifted in a regular manner and fed into the beaters, the first of which is a cylinder with four longitudinal blades; it then passes to the second, a cylinder armed with four rows of strong teeth. This double beating has the effect of opening the wool and facilitating its being taken by the teeth of fifty-four comb blades fixed on a hollow cast iron cylinder 22in. in diameter; between each comb blade a long slit is made about ⅝in. in width, extending the whole length of the cylinder; this is for the purpose of keeping the combs free.

The openings of the grating under the first beater can be regulated so as to facilitate the exit of the burrs.

The production of this machine is from 88lbs. to 110lbs. per day.

In the next process, of teazing, the wool is put into the self-acting feeder of a machine, consisting of an iron cylinder covered with twenty-four iron bars, each armed with a double row of strong teeth, 2in. in length. This machine is provided with an arrangement for oiling the fleece previous to its being carded, for the purpose of softening the wool and preventing the short fibres from flying.

The wool is next carded in a set of three machines, consisting of "scribbler," "intermediate," and "condenser." The main cylinders of these machines are 44in. in diameter, each with five workers and five strippers about a fourth of the size of the workers. These machines are 44in. in width on the wires.

The wool is supplied to the "scribbler" by means of M. Bolette's self-acting feeder; and the burrs are knocked out from the wool before reaching the main cylinder by means of a small burring-roller armed with saw-blades.

The sliver delivered by this machine passes on an endless feed-cloth to the "intermediate" card, where it is laid obliquely across the feeding-lattice by means of Apperley and Clissold's patent feeder. The sliver delivered by the intermediate serves to supply the condenser in the same manner. The fleece is stripped from the condensor by two doffers, and the fifty strips are felted by passing between two pairs of endless leather bands or rubbers having an alternate motion across them. This machine delivers fifty good threads and two wasters at ends.

M. Mercier exhibits a self-acting mule of 400 spindles fitted with a "double speed," which is very serviceable; it being desirable to twist the thread whilst being drawn just sufficiently to prevent its breaking, and when the carriage is at the end of its stretch to give it an extra twist.

For the treatment of long wool M. Mercier exhibits a carding engine 44in. in width, consisting of two main cylinders, and provided with a self-feeding apparatus, similar to that previously described, breast rollers, and burring cylinder armed with saw blades.

The wool, after the burrs have been knocked out by the burring-cylinder, is transferred to the breast roller furnished with three working rollers and clearers, where it is prepared for the first main cylinder; this is followed by another roller of the same diameter as the breast roller to prepare it for the second main roller. The fleece is removed in the usual manner by the doffer and a vibrating comb and formed into a sliver which is wound into a ball for supplying the combing machine.

The combing-machine, which is of most novel construction, is the invention of Mr. Noble, and produces from 200lbs. to 700lbs. per day.

This machine consists principally of a circular horizontal comb, about 5ft. in diameter, formed of needle points, with two small circular combs revolving tangentially to the larger one, of the same diameter. The balls of slivers, seventy-two in number, are placed in a framework underneath, and, revolving with the comb, the ends of the slivers pass separately through holes and through guide troughs; the slivers are kept from unrolling too quickly by a small weight under which they pass in the troughs. These troughs, in revolving as they approach the points of contact with the smaller combs, are raised, by means of a fixed cam or incline, up which they travel. The ends of the slivers passing to the comb are pulled out by the slight resistance offered by a bar under which they pass; the ends thus pulled out project over the inner and outer combs at their two points of contact, and the tufts of wool are placed on the teeth of the combs by a descending brush at each end of the crank shaft, making about 300 revolutions per minute whilst the large comb makes from three and a half to four revolutions. As the combs revolve, the ends of the tufts of wool placed on the teeth are guided by endless bands of leather between four pairs of fluted rollers, which are placed in convenient situations for the purpose of forming two slivers from the large comb and one from each of the smaller ones. These four slivers are then passed to the top of the machine, where they are formed into one by passing through a series of rollers and wound into a ball. The short refuse wool remaining between the teeth of the combs are removed by triangular plates or cleaners, and led away to cans placed at the bottom part of the machine.

The fibres of the wool are drawn out and laid parallel, either after combing or carding, by means of a screw gill. The gill head is supplied with a certain number of balls of sliver, which are placed in a crul or framework for that purpose. This machine is composed of an endless succession of bars called "fallers," bearing combs of closely-ranged steel points, through which the slivers are drawn. These bars are guided forward by means of two screws, with an eccentric at the ends, for the purpose of lowering the gill bar on to another pair of screws revolving in the opposite direction, by which they are brought back to their former position, into which they are lifted by other eccentrics. These slivers are held back by a holding-back roller, so as to allow the teeth of the gills to act upon the wool.

A self-acting mule of 450 spindles and four rows of drawing rollers is exhibited by these makers.

M. Vouillon, of Louviers (Eure), 38, shows a machine, constructed by M. Mercier, for the production of "fils fentres," threads which are not spun, but felted. The thirty slivers from the condenser are passed, on an endless felt band, covered with linen; under four wooden rollers, covered in like manner. These rollers have an alternate motion across the endless band, and in this manner the slivers are rubbed into yarn. A steam pipe is introduced between the first two rollers, for the purpose of heating the wool in order to facilitate the operation of straightening the fibres.

Messrs. Stehelin and Co., of Bitschwiller (Haut Rhin) 61, exhibit both woollen and cotton machinery.

For cotton, they exhibit a set of two carding machines with the intermediate process of lap doubling. The "breaker" carding machine is of the usual construction, with workers and cleaners, and the "finisher" is furnished with eighteen self-stripping flats on Wellman's system. Besides these, this firm exhibit drawing, slubbing, and roving frames, and self-acting mule, of good design and construction. The self-acting mule is of 442 spindles, with four pairs of drawing-rollers, the end pair of which are

weighted. The chief novelty in this mule is the form of the carriage, the back of which, in plan, forms a parabolic curve, instead of the back and front being parallel, as those generally in use.

For wool they exhibit two carding machines and a circular wool-combing machine of ingenious design. The wool, in ten or more slivers, is led forward by a screw gill, on which it is placed by a descending brush; the tuft of wool is then seized by a pair of jaws, that take it forward; a comb next takes it from the jaws and deposits it on the revolving circular comb; the ends of the fibres which project outside the teeth of the comb are guided by an endless leather band, to a pair of fluted rollers, by means of which they are drawn away from the teeth of the comb and formed into a sliver by passing through the centre of a hollow revolving cone, and deposited in a can at the side of the machine. The waste wool remaining between the teeth of the comb, is cleaned out by means of triangular plates, and drawn away by a pair of fluted rollers and deposited in another can.

The production of this machine is from 220lbs. to 660lbs. per day, according to the quality of the wool that is combed.

Messrs. Morel and Co. (82), of Roubaix, Nord, also exhibit a circular wool-combing machine. The slivers, supplied from fifteen bobbins fixed in a creel, are brought forward over the circular, horizontal revolving comb, where the tuft of wool is seized by a pair of jaws and placed upon the teeth of the comb by a descending brush; the fibres projecting from the comb are guided by an endless leather band, and are drawn away by a pair of fluted rollers and formed into a sliver, which is deposited in a can. In this machine there are two feeds, the one opposite the other; and two slivers of combed wool are formed, one on each side. The short waste wool is cleaned from between the teeth of the comb by means of triangular plates, and led away by a pair of fluted rollers to a can. The circular comb is formed of eight concentric rows of steel teeth fixed on a revolving cylinder; the cam motions by which the jaws and brush receive their respective movements are formed by a projection cast on the inside of the cylinder.

Messrs. Pierrard-Parpaite and Sons (93), of Reims (Marne), show important and well-constructed machinery for cleaning and spinning wool, consisting of an opener, scouring and wringing machine, carding engine, and continuous spinning frame.

The opener consists principally of a cylinder provided with a quantity of conical teeth fixed slightly inclined in the direction of the revolution. The wool is fed in on an endless lattice, the fibres are drawn out and opened, and the inclined teeth tend to send the wool forward and deliver the wool on the opposite side of the machine.

The scouring machine consists of several vats, into which the wool is steeped, containing alkaline lye, where it is worked about by forks moved by cranks; it is then taken out, rinsed, and dried. These vats are placed at different levels, so that the liquid in the top one, which receives the clean water, can be emptied easily into the next, and so on in succession. The wool is dried by being passed between rollers covered with woollen felt, which undergo considerable pressure, and effectually squeeze out all the water.

The carding machine exhibited by this firm is of the usual construction, with double doffing rollers and leather rubbers for felting the threads.

The principal feature in the spinning frame is that the spindle and flyer work quite independently of each other, and are driven by independent gearing, the flyer with a constant, and the spindle with a variable, speed. Each spindle and flyer can be stopped in a very simple manner, without its being necessary to stop the whole machine. The bobbins filled with yarn from the roving frame occupy the top part of the machine, whence the yarn passes through the drawing rollers to the spindles through the hollow part of the flyer, which is provided with arms of equal length with a spiral groove cut in one of them, down which the thread is led, and in this manner is protected from the effects of the centrifugal force occasioned by the high speed of the spindles.

A continuous spinning machine is exhibited by M. Ryo-Catteau (35), of Roubaix (Nord), the rail of which is lifted by a cam motion arranged in an ingenious manner.

A flax-hackling machine, with vertical sheets, is exhibited by Madame Ward (159), of Lille (Nord). The flax, suspended in its holder, is passed progressively from one side of the machine to the other on a slide placed above the tackle-sheets, and is thus hackled at the same time on each side in its course through the progressively finer hackles. The hackle-sheets are kept clean by means of brush-rollers at the bottom part of the machine, and they are cleaned by means of rollers covered with card clothing, from which waste is doffed by means of a vibrating comb. The vertical sheets run together parallel, and are so geared that the hackles of one intersect the interstices of the other.

The only ropemaking machinery in the Exhibition is that shown by M. Ouarnier-Mathie (54), of Compiègne (Oise). These machines occupy but little space, and ropes of great length can be made without the necessity of long ropewalks.

M. Vimont (60), of Vire (Calvados), shows a throstle, or continuous spinning-frame, of novel construction. The wool, after passing through the drawing rollers, is twisted by passing through a small eye, making about 3,000 revolutions per minute under tension. The tension is produced by the thread passing over two triangular flyers. The winding on is effected by the ring and traveller, and the copping motion by a rack and pinion for lifting the rail.

A most effective machine is exhibited by M. Buzzon, of Paris, for preparing shoddy of woollen rags, for re-carding and tearing up other rags for papermaking, &c. The rags are fed in by means of an endless feed-cloth between a pair of iron rollers, the bottom one of which is covered with indiarubber, within range of a drum making about 1,000 revolutions per minute, covered with steel teeth resembling those of a circular saw; the top roller is kept clear by means of a knife which prevents the wool being wrapped round it. The drum is cleared of wool on the delivery side by a circular brush. This machine requires about 1¼ horse power, and produces from 300lbs. to 400lbs. per day.

A circular wool-combing machine is exhibited by Messrs. Prouvost and Co. (43), of Roubaix, Nord.

Eight slivers contained on bobbins are placed in a creel, and their ends are brought forward on a carriage, working on a horizontal slide. The tufts of wool are taken by a comb having a backward and forward movement towards the revolving circular comb, on which they are placed by a descending brush. The ends of wool projecting on each side of the comb are guided by endless bands of leather; and the two slivers thus formed are drawn into one by a pair of fluted rollers through a hollow revolving comb, and deposited in the coiling-can. The waste wool remaining between the teeth of the comb is cleaned out in the usual manner, by means of triangular plates.

The principal exhibitors of ropes and cables are Messrs. Besnard and Genest (36), of Angers, Maine-et-Loire, who show a pyramid composed of wire and hempen ropes and cables for the Imperial and merchant navy; a coil of flat rope made from the fibres of the aloe, for the mines of Blanzy 231 fathoms in length and weighing upwards of three tons; a coil of flat wire rope, weighing upwards of four tons, and 260 fathoms in length, intended for the use of the mines at Creusot; a flat hempen rope, 300 fathoms in length, and weighing upwards of five tons, with various other coils of cables of large dimensions for mining purposes, form the base of the pyramid. Upwards of 800 workmen are employed by this firm for the manufacture of cables and cordage, with an engine-power of 300 horses.

The machinery used by this firm has been chiefly furnished by Messrs. Combe, of Belfast, for combing hempen and other fibres, and the carding-engines by Fairbairn, of Leeds.

Some excellent samples of wire, hempen rope, and rope made from the fibres of the aloe, are exhibited by Messrs. Marcheteau, Potraies, and Laroche, of Angers (33).

The Commission des Ardoisières of Angers (98) show some good samples of both flat and round wire rope.

The generality of the cables and ropes in the French department is of excellent quality.

The principal exhibitors of card clothing, separate parts of machinery, such as spindles, flyers, bobbins, gills, combs, used in the preparation of textile fabrics, are Messrs. Harding and Cocker, of Lille (120), Messrs. Scrives, of Lille (133), Messrs. Metcalfe, of Meulan, Seine et Oise (21), and numerous other firms.

The machinery for silk throwing does not generally present any special features or novelties in construction.

Some excellent apparatus for weighing and testing the strength of silk, and parts of silk throwing machinery, are exhibited by Messrs. Burdet (149) of Lyons, Mr. Alcan, of Paris (22), and a few other exhibitors.

(To be continued.)

CIVIL ENGINEERING, PUBLIC WORKS, AND ARCHITECTURE, CLASS 65, IN THE PARIS EXHIBITION.

By Captain Ponsonby Cox, R.E.

Although there is no science which has given to the world such important practical results within the last few years as that of civil engineering, and though there is probably none which has made more real scientific progress, its recent progress and its later results are far from being adequately represented in the Exhibion of 1867.

In the French section only is there a satisfactory exhibition in civil engineering proper; the other European nations, as well as the United States of America, are but slightly represented. Our own country can hardly be said to be represented at all.

This is much to be regretted, for undoubtedly a well-assorted collection of models or drawings of the most important engineering works scattered

all over the world, which are due to the energy and skill displayed by English engineers within the last few years, would, if placed side by side with the magnificent collection of models and plans in the French section, have formed an exhibition most interesting and instructive, would have added much much to the available knowledge of civil engineering of the world, and saved much of the labour thrown away in re-inventing. From this point of view, the Paris Exhibition cannot but be looked upon as a great opportunity lost. The public works of London alone might have supplied admirable examples in the great railway stations and river bridges recently constructed, as well as the works connected with the main drainage and the Thames embankment. The materials for a good display exist, no doubt, in the works of Great Britain and her colonies, but we do not possess (nor does any other nation possess), for tabulating those materials, such a machinery as France has in her establishment "des Ponts et Chaussées," her "Ecole des Mines," "des Arts et Métiers," &c.

The French collection is unrivalled. It contains models, admirably got up, of bridges, viaducts, reservoirs, docks, tunnels, &c., with complete plans illustrative of all recent public works; a brief but clear report of each work is to be found in a volume published under the auspices of the Ministère d'Agriculture, du Commerce, et des Travaux Publics. From this source have been derived the figures which will be found in the short notice of some of the most important public works attached to this memorandum.

Leaving France for the present, we find the most important exhibit connected with civil engineering in the English section to be the application to lighthouses of the dioptric system of light of Augustin Fresnel, which system is now being generally introduced, both for fixed and revolving lights. The Trinity House and the Commission of Northern Lights have sent a series of models of lighthouses, light-ships, &c., and several lanterns of different sorts and sizes. These lanterns are all from the works of Messrs. Chance, of Birmingham, and comprise the improvements made by them as well as by Mr. Douglas for the Trinity House, and Messrs. Stevenson for the northern lights. The dioptric system has been recently admirably described by Mr. Chance in a paper read at the Institution of Civil Engineers. It consists of a structure of segments of glass enveloping a central flame, whose focal rays are parallelised in a horizontal direction and deflected in the case of fixed lights in meridian planes only, whilst in revolving lights the rays are gathered into a number of cylindrical beams, which are made to pass successively before the observer by the rotation of the apparatus. The dioptric instrument is further described to consist of three main divisions; an equatorial belt of the sphere of light proceeding from the flame is acted upon by refraction, but the rays above and below this belt are deflected by local reflection; the relative illuminating values in the horizontal plane of these divisions of the part of the luminous sphere acted upon are in the proportion of, upper reflectors, 20; refracting portion, 70; lower reflectors, 10.

It is most important to send towards the sea horizon the brightest sections of the flame. The Trinity House Corporation exhibits the application of the magneto-electric light, for the discovery of which the world is indebted to Professors Faraday and Holmes; the former discovered in 1831 that a spark could be produced by magneto-electricity; the latter, that by this means a continuous flame could be kept up. In 1857 the discovery of Professor Holmes was first applied in the South Foreland Lighthouse. It has since that date been submitted to long practical trial, the result of which has been the determination to adopt it in other lighthouse stations.

The machine for the production of the light consists essentially of six brass wheels, with sixteen bobbins of insulated copper attached at equal distances to the circumferences of each wheel; inside each bobbin is a hollow core of soft iron; the wheels are all fixed upon a shaft, which is driven by a steam-engine. In turning, every core of each wheel is brought at the same instant between the opposite poles of two magnets, which pair of poles it also quits at the same instant. The core of every bobbin has its magnetism thus reversed by the revolution of the wheels 107 times per second. This reversing of the magnetism induces a current of electricity in the bobbins; the combination of the currents produces one of sufficient intensity to give a powerful light. The lantern in which the electric light is used was designed by Messrs. Chance, by whose arrangement the bars of the lanterns are fixed obliquely, and by this means the amount of light stopped by the lantern is reduced to a minimum.

The above appear to be the most striking exhibits in the English section; and, indeed, there is little else calling for special notice in engineering, properly so called. Mr. H. Cole has sent a specimen of enamelled ceiling which in many cases might be adopted with advantage; and the exhibits of ornamental tiles by Minton and Maw, and of terra-cotta by Blanchard, Blashfield, and Pulham, are prominent instances of improvement in materials of construction.

Messrs. G. Smith and Co. exhibit a specimen of the façade of the South Kensington Museum, showing an admirable combination of finished brick-work with terra-cotta mouldings and enrichments.

Turning to Belgium, we find in an annexe a model of the system adopted by M. E. Boucqueau in the construction of a tunnel on the line of railway from Brain le Conte to Gand. The tunnel, which is about 440 yards long, is carried through a hill on the bank of the River Dendre. It is approached on the north side through a considerable cutting, and the line at the south side is carried on an embankment. It was necessary, in order that the work should proceed with rapidity, that the tunnel should be attacked at several points at once. Sinking shafts from the ground above and lifting the stuff over the hill would have been attended with considerable expense. M. Boucqueau consequently determined to drive in a small gallery, parallel to the tunnel, at one side of it and about 2ft. below its general level. From this gallery adits were driven right and left at right angles to the axis of the tunnel. The whole of the *deblai* was taken out through those adits and disposed of at the south or embankment side of the hill; whilst the small gallery, being somewhat below the proposed level of the permanent way in the tunnel, kept the workings free from water. The gallery was 5ft. wide by 6ft. high. Its sides and ceiling were supported with sheet piling and lagging. The distance between the axes of the small gallery and the tunnel was 57ft.; the branch adits were about 70 or 80 yards apart. A tramway was laid along the gallery, with turn-tables for the earth-waggons at the mouth of each adit. This system claims to have effected a considerable saving in time and money as compared with the plan of sinking shafts from the top; but it is probably only of exceptional applicability, as in most cases the ordinary system of working from a heading within the line of the tunnel itself would be less expensive.

Prussia exhibits a system of centering lately used in tunnelling, the essential feature of which is the substitution of a portable iron framework for the ordinary timber centering.

This system has been adopted in the construction of the tunnels of Narusen and Ippenson. A framework consisting of cast-iron segments bolted together supports a second iron framing, which latter is formed of railway metals, bent and fitted together with radiating joints, like the voussoirs of an arch. These two frames form the principals of the centering. The upper voussoirs are attached to the lower frame by clips, which overlap the lower flange of the railway metals of which they are formed. The voussoirs can be removed one by one as the masonry of the arch is brought up to remove them.

From the soffit of the iron principals are suspended hanging pieces, also of railway iron, which support cross bearers carrying tramroads in two or three tiers, as may be necessary, to remove the excavations and to supply the materials of construction.

The advantages claimed for the system are that, from the interior space being not hampered by uprights to carry the principals, as would be necessary if wood were used, the work can be carried on with much greater facility; it is easier to range out the line and to work truly, to ventilate the tunnel, and to get rid of water. The first cost is stated to be very little, if at all, above wooden centering; and, from the greater durability of the materials, it is stated in the long run to be more economical. It is open, however, to the objection that unequal pressure of the surrounding earth, if sufficient to fracture the centering, would produce much more serious damage than with the ordinary systems in use. The design is by M. Franz Reiha.

In the southern States of Germany a remarkable example of cheap railway-bridge construction is exhibited in the Bavarian section, by a model, on a scale of 1·30th full size, of a bridge of boats over the Rhine, between Maximilians-au and Maxau, which carries a loop-line of the Carlsruhe and Winden Railway, opening up a considerable local traffic, and carrying the coal trade between Bavaria and Baden. The main line crosses the Rhine at the bridge of Kehl.

The road traffic at this point was formerly carried over a bridge of boats, situated about half a mile higher up the stream than the present one; this has since been removed, and the ordinary, as well as the railway traffic, crosses the new bridge.

The Rhine at Maxau is 240 metres wide; its bed, which is of gravel, is constantly influenced by the deposit brought down by the current, the navigable channel being thereby shifted alternately to the Bavarian and Baden bank. This cause has made it necessary to make two parts of the bridge, one on each side, movable, to allow the passage of the river traffic. The bridge is at right angles to the stream; its length over all is 362·80 metres, of which 234 metres is actual bridge, the ramps of approach from each shore being 64·10 metres in length. These ramps are supported upon timber stages, and their gradient can be regulated by a system of screw gear to suit the level of the stream. The recorded readings of the Rhinometer at Maxau show the extreme range of variation of water level to be 5·20 metres, *i.e.*, between 3·60 above and 1·60 metres below the zero of the scale. These extremes have, however, been but rarely reached; the mean level of the Rhine is 2·50 metres on the scale, and this height of water gives an ascending gradient of 1 in 60 to the approaches to the bridge; the extreme reading of 3·60 metres on the scale giving a gradient of 1 in 30.

The bridge consists of twelve rafts, six of which are easily removable to allow the passage of boats; these rafts are carried by thirty-four pontoons, or boats substantially built of oak, of which material are also the principal beams and the upper planking of the roadway. These pontoons are 65ft. 6in. long, 12ft. 2in. broad, and 4ft. 7in. deep; except the two pair next the shore, which are somewhat larger.

In order to allow the permanent way to adapt itself to the rise and fall of the water level, as well as to the deflection of the roadway from the immersion of the pontoons, on first taking the weight of the train as it leaves *terra firma;* the joints of the longitudinals and the metals which they carry are made with a hinge where their shore-end and bridge-end abut, besides which these ends are each borne upon a strong coach-spring.

The general arrangement of the bridge, the position of the movable rafts, and the method adopted of attaching the various parts to each other, will be readily understood.

This bridge was designed by M. Basler, engineer in chief of the railways of the Palatinate. The total cost of its construction was £12,000

In the Italian section is an atlas containing plans and sections of the great tunnel of Mont Cenis, which is being constructed, as is well known, to unite the Paris, Lyons and Mediterranean Railway with the Italian railways, so as to establish communication with an unbroken gauge between Calais and Brindisi, a distance of 1,390 miles, and to annihilate the danger and difficulties of crossing the Alps; which will, however, be much reduced, long before the completion of the greater work, by Mr. Fell's summit railway. The entrance on the French side, 1½ mile from Modane, is 439ft. lower than the Italian end at Bardonnèche; this would give a gradient in the whole length of the tunnel (7 miles 1,007 yards) of 1 in 91 nearly. The tunnel is not, however, being executed at a uniform gradient; a fall is given towards both ends from the centre of 1 in 2,000 and 1 in 45 respectively. The works, which were commenced in 1857, were first carried on by manual labour. During 1858, 844ft. were thus driven at the Bardonnèche end; this was the greatest progress which has been made by manual labour in one year. The works are now being carried on with boring machinery driven by compressed air, motive power being obtained by water at the French side from the River Arc, at the Italian side from the River Mezelet, from which sources the water is led to reservoirs. Since the adoption of machinery, the progress has been much more rapid. In 1865, the length driven amounted to 2,502ft. on the Italian side.*

Commencing from the French end, the first 2,350 yards have been through schist; then 550 yards of quartz were encountered, through which the progress was very slow. This has been cut through, and the tunnel on the French side is now through limestone, which is not quite so difficult as the quartz. The present progress through the limestone is about one yard per day; through the quartz it hardly reached 2ft. After passing the limestone, schist is again reached, which formation extends to the Italian end. It is now stated that the probable date at which the excavation will meet will be some time in 1873.

The public works recently executed by the Italian Government are also shown in an atlas of plans; but they are principally military barracks, and do not appear to be very important or to possess much general interest.

The most important work of civil engineering shown by Spain is the breakwater of Tarragona, of which there is a sectional model.

The work, which is still in progress, can lay claim to priority in point of age to any work of civil engineering in the Exhibition, its commencement dates as far back as 1790.

It is intended, when finished, to be about 1500yds. long, with a total width at top of 100yds., including a pier on the inner side of 65yds. wide; the base of the breakwater is nearly 300yds. wide. It is formed of pierre perdu. Some of the blocks in the base are of enormous size; their interstices are filled in with smaller blocks; the top stratum is of concrete up to the level of the pier. The work has been carried out principally by convict labour.

It is in the French section, as has been already stated, that we find by far the most important exhibition of works of civil engineering. France undertakes to tell us what her engineers have been doing during the last few years; she shows immense progress in the science. A careful study of the admirable collection of models and plans exhibited by the Public Works department, cannot fail to produce the conviction that the works they represent have been most scientifically designed, and executed with great care, great practical skill, and economy. A very slight description is given of a few of the most remarkable of these works. The first selected for notice is the great swing bridge of Brest, which spans the inlet of Penfeld, between the towns of Brest and Recouvrance. Two models—one on a scale of 1-50th full size of the whole bridge, another, 1-10th full size of one of the piers—exhibit the construction. This bridge has a greater span than any bridge of similar construction in the world; it is well and solidly constructed, and has stood the wear and tear of ten years without any considerable repair.

The distance between the sea-face walls of the Penfeld (571ft.) is spanned by two wrought-iron lattice frames, revolving upon turn-tables which crown two circular towers, 34ft. 9in. in diameter and 347ft. apart in the clear; the latter dimensions is the total width of the fair way of this part of the naval harbour. Each of these two frames consists of two girders, 25ft. 4in. deep over the piers, and 4ft. 7in. in the centre; these are strongly braced together with perpendicular and diagonal braces, and support the roadway, which is itself constructed so as to add considerably to the rigidity of the structure.

The shore ends of the frames form a rectangular box, which contains the counterweights of the bridge. The total weight borne upon each pier is 590 tons; the turn-table on the summit of each pier is 29ft. 6in. in diameter, and has fifty rollers, each 1ft. 7in. in diameter and 1ft. 11in. in length. The means of opening and closing the bridge is extremely simple; it consists of a pinion fixed to the revolving part of the bridge, gearing into a horizontal cog-wheel on the pier. The motion is transmitted by an intermediate to an upright shaft, which comes up through the roadway of the bridge, and is crowned with a capstan. Four men with capstan-bars can open the bridge in ten minutes. Should it be necessary to repair or replace any of the trucks, or any other part of the mechanism of rotation, the whole weight of the bridge can be lifted off its bed by means of four hydraulic presses in the centre of the piers.

The foundations of the piers are on the solid rock. They are built of rubble masonry, faced with ashlar. The sea walls are of rubble, with dressed quoins; the weight of the metal used in the construction of the bridge is 1,180 tons.

The total cost, including foundations, was £84,000.

The design was by M. Oudry; the works were carried out by MM. Schnider and Co., of Creusot.

A very remarkable exhibit by the Ministère des Travaux Publics is a model (1-25th full size) of a masonry arch designed and built by M. Vaudray, engineer of the Ponts et Chaussées, as an experiment preliminary to the construction of a bridge over the Seine, to connect the Rue du Louvre and the Rue de Rennes. The bridge in question had to span the river exactly over the locks of the Canal de la Monnaie; and the necessity, on the one hand, of keeping the springing of the arch above the lock walls, and, on the other, of keeping the level of the roadway down to the existing level of the streets leading to it, confined the rise of the arch to a height not exceeding 7ft., whilst the span had to be nearly 125ft.

In order that the new bridge should be in keeping with the numerous important public buildings in its vicinity—viz., the Pont Neuf, the Louvre, the Hôtel de la Monnaie, &c., it was very much to be desired that it should be of stone: and, the possibility of building so flat an arch with the span required in that material having been questioned, it was determined, before carrying out the project, to build an experimental arch which should fulfil the required conditions. The spot selected for the experiment was the quarry of the plains at Soupes, sixty miles from Paris, on the Bourbonnais Railway. The natural quarry face of the rock was shaped to form one abutment, the other was a massive block of masonry built for the purpose.

The description and general dimensions of the arch are as follows:—Its form is a segment of a circle, of which the chord is 124ft., the versed sine 6ft. 11in. It is built entirely of cut stone; the number of the voussoirs in each ring is seventy-seven, diminishing in depth from 3ft. 7in. at the springing to 2ft. 8in. at the keystone; the beds and joints of the voussoirs are dressed with the greatest care, and are laid in Portland cement mortar, the composition of which is two parts sand to one part cement. The thickness allowed to the mortar joints was ⅜in. The joints next the skewback were not finished until after the completion of the ring, having been meantime kept open with fir wedges.

The artificial abutment is 27ft. in height, 49ft. in mean thickness, and 12ft. wide (this is also the width of the arch); it was built of rubble masonry, well bonded together and laid in Portland cement mortar—one part of cement to three parts of sand; its construction occupied twenty days, the laying of the voussoirs seventeen days.

The arrangement for striking the centering was by the means of dry sand contained in iron cylinders, hereafter described. This method, it will be observed, is peculiarly well adapted for so critical an experiment as the one under notice. Arrangements were made to observe with the greatest exactitude the effect which should be produced on the arch by the removal of the centering. The arch was left to set four months; the centering was then eased by allowing the sand to flow regularly from the cylinders. In an hour daylight was perceptible between the soffit of the keystone and the lagging; in two hours the arch and the centering were quite separate. The result upon the arch was then found to be as follows:—

The crown had come down 6-10ths of an inch, the joints of the skewback had opened on the built abutment side 7-1000ths of an inch. After the lapse of three days the arch was observed to have come down 7-100ths of an inch more.

It was then loaded with a weight of 360 tons, disposed over the whole surface of the roadway; the loading occupied thirteen days. When complete the crown was found to have come down 3-10ths of an inch.

Since then nothing has stirred. The arch was afterwards tested by a weight of five tons being allowed to fall on the roadway vertically over the keystone, from a height of 1ft. 6in., but no joint has opened, nor has the bridge sustained the slightest injury.

This interesting experiment satisfactorily proves that the relative pro-

* At the end of last September the amount completed on the Italian side was 7532·25 metres, leaving 4687·75 metres to finish.—Ed. Artizan.

portions of rise to span in large masonry arches to which engineers have hitherto limited themselves may be largely modified: it is quite clear, however, that such constructions require very accurate work and the greatest care in execution.

Allusion has been made above to a method of easing and striking centering by means of sand. A full-size model in the park shows this method, now frequently adopted by French engineers for easing large centerings from arches on completing of works—viz., by resting the principals of the centering upon sand contained in iron cylinders, from the bottom of which the sand is allowed slowly to escape.

Each principal is supported upon round props, fitting as a piston into a cylinder containing fine *dry* sand.

The cylinders are of sheet iron, one thirty-second of an inch thick, one foot high, and one foot in diameter. About two inches from the bottom they are pierced with holes about three-quarters of an inch in diameter, which are stopped with common corks. To ease the centering the corks are removed, the sand then escapes through the holes, until a cone of sand is formed at the base of the cylinder. The formation of this cone arrests the further escape of the sand, and therefore the descent of the piston, until the cone is swept away, when it re-forms. The sweeping is repeated until the piston has descended sufficiently to detach the centering from the masonry.

By taking care to sweep away the same cones simultaneously, the lowering of the centering can be performed with perfect evenness, and as gradually as may be desired, by one millionth of an inch, if necessary; whilst, as no force whatever is required to be used, the arch is not subjected to the slightest shock during the operation. This system was originated by M. Beaudemoulin, engineer in chief. It has been applied to many important works; amongst others, to the fine bridge of Austerlitz.

Three fine examples of engineering are exhibited in models, one twenty-fifth full size, of the three iron railway viaducts of Busseau d'Ahun, la Cere, and Du Midi; they are all three of the same type. One of them is the viaduct of Busseau d'Ahun, which carries the Chemin de Fer d'Orleans between Montluçon and Limoges across the River Creuse, close to the junction of Busseau d'Ahun.

It is composed of a lattice girder in six spans, supported upon iron columns, surmounted upon masonry bases.

Each of the five piers consists of eight hollow cast-iron columns, in two rows of four (transversely to the roadway), crossbraced horizontally and diagonally with rolled iron joists; these piers support four main lattice girders, connected by cross girders, bearing a timber floor and continuous sleepers.

The eight columns of each pier batter towards a point 148ft. above the roadway, thus forming a four-sided truncated pyramid; the same batter is given to the masonry bases upon which they are mounted; this arrangement gives a very pleasing effect to the structure. The bases are rectangular blocks of ashlar, with dressed quoins carried up from the rock; the iron superstructure is secured to them by eight holding-down bolts of 3½in. diameter, round iron.

The work of erecting this viaduct was performed with great skill; the main girders were riveted together on the bank, and launched into place without the use of scaffolding; this was effected under the direction of M. Moreaux. The design of the viaduct is due to M. Nordling. Its total cost was £60,000 sterling.

The fine and well-proportioned iron lighthouse in the park has been constructed by M. Rigolet, of Paris, from the design of M. Reynaud, Inspecteur Général des Ponts et Chaussées. It is destined for the rocks called "Les Douvres," situated midway between the islands of Guernsey and Brehat, off the coast of Brittany.

The rock on which this lighthouse is to be built is in the middle of the south edge of the shoal; its summit is washed at high tide. The masonry foundations of the lighthouse are 6ft. 10in. high; the height of the iron column is, from base to floor of gallery, 158ft. 6in.; to top of lantern, 184ft. 2in. high. In plan it is a sixteen-sided polygon. The diameter of inscribed circle at base is 13ft. 6in.; at top, 13ft. 2in. The light is 174ft. above high-water level.

Round the base of the column are the store-rooms and living-rooms of the lighthouse-keepers; above these are rooms for the reception of persons rescued from shipwreck. In the centre of the column is a cast-iron staircase from the base to the lantern.

The chief peculiarity of construction of this lighthouse is that the structure depends for its strength wholly upon its skeleton; the iron plates which are attached to it are merely a skin, and are not at all relied upon for strength; whereas in wrought-iron lighthouses of ordinary construction strength is obtained by the riveting together of the plates of which it is composed. The reasons which Mr. Reynaud has given for this departure from usual construction are—1, that plate iron is liable to rapid decay from oxydisation; 2, the ordinary mode of construction necessitates special appliances and scaffolding, &c., not easy to erect upon a rock situated as is the Douvres, whereas he has been enabled to arrange the parts of his structure so that it can be put together on the site with great facility. The skeleton of the structure consists of sixteen frames, forming the sides of the polygon, fifteen panels high. Each panel is formed of 7⅞in. by 3⅜in. T iron, securely riveted together. These panels are bolted each over each, and strengthened at their edges by a binding piece of 7in. by 3⅞in. T iron bent to the shape of the polygon. The skin is ⅜in. plate iron at the base, diminishing to ¼in. at the summit of the column. The joints of the plates are overlapped with strips of ½in. iron. The balcony of the lantern is carried upon cast-iron cantilevers. The light is dioptric, revolving upon ten steel friction rollers upon a hardened steel tread plate. The supply of oil is regulated by clock-work, manufactured by M. Lepaute, of Paris.

The weight of the lantern is about four tons. The total cost of construction was (including erection in the park and taking down hereafter) £10,000 sterling.

The tunnel of Ivry, a model of which (1-25th full size) is exhibited, is chiefly remarkable for the skilful manner in which the difficulty of obtaining a secure foundation for the masonry of the tunnel has been overcome.

This tunnel carries the girdle railway of Paris beneath the Champ de Mars of Ivy, and is 220yds. long. Its permanent way is about 40ft. beneath the surface of the ground. The formation through which it is driven is sand, above a marl bed, which overlies a stratum of calcareous stone, good for building purposes, and formerly much used in constructions in Paris. The quarrying of the stone has left considerable cavities beneath the site of the tunnel, which have necessitated the precautionary measures for securing its foundation shown in the model.

To carry down the side walls of the tunnel to the solid floor of the quarry, as first intended, would have involved immense expense; and as it was found that the stratum which intervened between the required level of the permanent way of the railway and the excavation beneath was of a solid nature, it was determined to shore it up from below with masonry walls, exactly beneath the site of the side walls of the tunnel, and to fill up the cavities between these lower foundation walls with rammed earth. To effect this, two galleries were driven beneath and parallel to the intended tunnel; these were lined with masonry walls, so placed that one (the thicker of the two and the nearest the axis of the tunnel) should coincide in plan with the side wall of the tunnel, and should support the stratum of rock upon which the latter should be built.

These minor galleries were arched in, and served as galleries of inspection, by means of which the foundations could be examined both during the progress of the work and after it had been tested by the passage of trains. Many difficulties occurred in the execution of the work, owing to the ground having been largely fissured by faults in the quarry veins. A serious obstacle was met with, owing to a part of the old quarry having caved in beneath the superincumbent earth. The earth which had slipped assumed the form of a truncated cone of about 30ft. in diameter at base and 15ft. at its upper surface. In order to carry the foundation gallery through this fault, it was necessary to support the whole circumference of the slip upon masonry carried up from the solid rock. This done, the whole of the loose *deblai* was removed through the gallery of inspection, and, piers being built up at the extreme edge of the slip, an arch was thrown across the space, and the pier wall of the tunnel built upon it. It will be readily seen that this was a critical and difficult piece of work. It was carried on night and day in reliefs, under the direction of M. Bassompière, engineer in chief des Ponts et Chaussées.

An extremely ingenious system of syphons, recently applied in France to large reservoirs for the purpose of getting rid of the surplus and storm waters, is shown by two models, one of 1-40th full size, and another of the head of the syphon-feeder 1-10th full size.

The system presents some novelty, has been found to work well, and it is intended to apply it to other reservoirs in France.

The apparatus consists of two cast iron syphon-pipes 27in. internal diameter, 8-10in. thickness of metal, through which the surplus waters are discharged. To these are attached two lesser auxiliary pipes, whose internal diameter is about 4in. These latter communicate with the larger pair at the highest part of their curve, and are the means by which the discharge is regulated.

In order to protect the apparatus from frost and from injury from any other cause it is inclosed in a masonry chamber formed in the dam, and communicating with a reservoir by a port, which is usually open; it can, however, be closed for repairs, &c. There is a second port in the chamber which is closed by a sluice-gate. This is only opened to empty either the chamber or the reservoir. The upper part of the auxiliary pipes or feeders, which have been described as being attached to the larger pipes, does not communicate directly with the reservoir. The upper part is within the masonry chamber, about ¼in. above the prescribed water level of the reservoir. Its attachment to the pipe is by means of a water-tight expansion-joint, which allows it vertical play. As long as the reservoir is below its prescribed water level the syphon is inactive; but as soon as it rises above that level it begins to flow away through the small pipe, and, the water continuing to rise, the head of the latter becomes completely submerged; the downflow of the water through the small pipe draws with it the air contained in the elbow of the syphon, and the latter begins to work until, the discharge having reduced the water to the

prescribed level, air is readmitted to the bend of the syphon, and its operation stopped. So long as the depth of water over the head of the feeder is less than 2in., the whirlpool formed by the pressure of the atmosphere at the orifice causes the syphon to draw air as well as water, and therefore to discharge with reduced volume; as soon, however, as the water has risen to 2in. above the head the syphon works full bore, and discharges at the rate of 1,507 gallons per second.

The apparatus is therefore self-regulating as well as self-acting.

The system claims, and appears to possess, the advantages of being simple in construction, certain in operation, and not liable to get out of repair.

The feed apparatus, which is the only novelty, is the idea of M. Hirsch.

The principal public buildings and restorations executed in Paris during the last twelve years are recorded in an atlas of plans exhibited by the Department des Travaux Publiques. The extent of these works may be gathered from their cost, £6,630,120. The designing of these works shows not only great skill expended upon the construction itself, but a skilful adaptation of site and judicious utilisation of ugly waste spaces have also contributed to the general embellishment of the capital. It will be remarked that in the designing of hospitals and lunatic asylums great care has been taken to obtain a cheerful look-out from the ward windows. In the arrangement of the public abattoirs the approaches from the railway stations have been studied so as to give the least amount of street through which cattle are driven, whilst the disposal of the dead meat is made as easy as possible. None of these details have been left to take their chance.

The next work selected for notice—an undertaking being carried on, not upon French territory, but the credit of which is due to France—is, perhaps, the most interesting object of civil engineering at present in progress in the world, viz., the cutting the maritime canal through the Isthmus of Suez; models, plans, photographs, and a panorama of which are exhibited in a detached building in the park, constructed in the style of an Egyptian temple. No one exhibit has attracted more of the attention of the visitors to the Champ de Mars than have these models, and none has better repaid the trouble of examination. The works which they illustrate deserve attention alike from their great magnitude and importance from an engineering point of view and from the greatness of the beneficial influence which their completion is likely to exercise upon the commerce of the world.

The idea of this great work, by which we hope the whole civilised world is shortly to be benefited, is due to M. le Baron Lesseps, who has long interested himself with the affairs of Egypt, having filled an important diplomatic post for many years in that country. The execution of the scheme is due to French engineering skill, and the principal part of the capital has been subscribed in France.

The works are illustrated by a model of the isthmus on a scale of 1-50,000th; the heights are comparatively exaggerated, 60 to 1; the width of the canal, 6 to 1.

The Isthmus of Suez, at the part selected for the operations of M. Lesseps, is about seventy-two miles wide, measured as the crow flies, from Pelousa, on the Mediterranean, to Suez, on the Red Sea. The level of these two seas is not far from identical, the mean level of the Red Sea being but 6½in. higher than that of the Mediterranean. The general character of the isthmus between Pelousa and Suez is flat, and it is the natural water basin of the adjoining countries, which slope gradually towards the isthmus, east and west, from Asia and Africa. Starting from Pelousa, and following, southwards, the line traced out for the canal towards Damietta, we come to the lagunes of Menzaleh. about twenty-five miles long, separated from the Mediterranean by a strip of beach, which runs out shoal for a considerable distance into the sea. The Mediterranean mouth of the canal is cut through this strip; and here, situated eighteen miles west of Pelousa, is Port Said, created by the company to be their base of operations, and where are established considerable workshops for the maintenance and repair of plant.

Formerly these desolate lagunes of Menzaleh were vast cultivated plains, which, fertilised by the Tantitique branch of the Nile, supported a considerable population, and grew a large quantity of the corn which supplied the granaries of ancient Rome.

After leaving the lagunes the line of the canal cuts through a strip of sand about four miles wide, elevated about 4ft. above the sea; this strip separates the lagunes of Menzaleh from those of Ballah, the width of which is fourteen miles. Then occurs the elevated plateau of El Guisr, the highest ground between Pelousa and Suez; through this the canal is carried in a very considerable cutting, nine miles and a half long, with a maximum depth of 55ft. After crossing this plateau a depressed plain is reached called Lake Timsah; the lowest level of this plain is 19ft. below the water of the Mediterranean. On the borders of the Lake Timsah, or Lake of the Crocodiles, is Ismailia, a town built by the company midway between the Mediterranean and Red Sea, where they have located the general direction of the works. The line then crosses a second elevated plateau called Serapeum, 46ft. above the level of the Mediterranean, and nine miles long. South of this lie the lakes of Amer, two shallow lagunes separated by a narrow strip of sand; the exact line which the canal will follow through Lakes Timsah and Amer has not yet been decided upon. This part of the canal will be left until the rest of the line is completed. Meantime, water communication across them is obtained by admitting the water of the Mediterranean into Timsah and the Red Sea into Amer, thus transforming them into navigable inland seas. Beyond the lakes of Amer is the raised ridge of Chalouf, 26ft. above the level of the sea, the southern slope of which forms the plain of Suez, elevated 6ft. 4in. above the sea level. After crossing this plain, the lagune of Suez is reached, which communicates by a shallow inlet with the Red Sea.

Thus the total length of the canal is about 100 miles, of which thirty-seven miles are in cutting, whilst sixty-three miles are at or beneath sea level.

The first work undertaken by the company, preliminary to their main work, was the extension, as far as Lake Timsah, of the old fresh-water canal, which, starting from Moës, wound eastward, past Ahissieh to Ras-el-Ouady. This extension gave them means of transport for their provisions and materials from the Nile into the very heart of the isthmus, a supply of water for their workmen and for their engines, and enabled them to establish their central depot of Ismailia. Southwards from Ismailia the fresh-water canal was continued nearly parallel to the intended line of the maritime canal as far as Suez, and northwards the water was led in pipes from a reservoir at Ismailia as far as Port Said, following the line of the works. The original source of supply of the fresh-water canal from Moës was supplemented by a cut from the Nile at Boulak to Abissieh, forty-four miles long; the cross section of the fresh-water canal is 56ft. at water level, 26ft. at bottom, and 6ft. 6in. deep.

The general dimensions of the maritime canal are:—Width at water level in embankment, 328ft.; ditto in cutting, 190ft.; width at bottom, 72ft.; depth, 26ft. 3in.; the batter of the sides varies with the nature of the soil, the steepest slope being about 2½ to 1.

The sectional form of the canal has been the subject of anxious consideration. It was originally intended to make it somewhat narrower than the above dimensions, and steeper at the sides; but it was found that at or near the water's edge a slope as steep as 2 to 1 was subject to degradation from the wash of passing vessels; the general batter from about 4ft. below water level to the bottom is now intended to be from 2½ to 1 to 3½ to 1, whilst the edge is considerably flattened so as to approximate to the shelving form which sand assumes when acted upon by the wave from passing vessels.

The first work of digging through the strip of head separating the Mediterranean from the lagune of Menzaleh was performed by fellahs supplied by the Egyptian Government; the mode of operation was the old one of scooping the sand and carrying it in baskets on the head. The work of the fellahs was confined to the higher and drier parts of the excavations, the lower part being performed by means of steam-dredges, twenty of which were put in operation by the company; these dredges were driven by 15 horse-power engines, lifting twenty-six gallon buckets at the rate of twenty per minute. The sand dredged north of the beach was deposited to form the platform upon which Port Said was subsequently built; the sand excavated on the south was placed so as to form the canal banks, *en cavalier*, through the lagunes. By these banks the waters of the canal were isolated from those of the lagunes, guarding at once against sudden variations of water level arising from storm, and protecting the bed of the canal from being silted up by sand blown across from the plains. A good illustration of the works in the great cutting of El Guisr, as carried on by fellahs, is given in the drawing which hangs on the wall on entering. When this cutting was about half accomplished the supply of fellah labour by the Egyptian Government was stopped; the primitive baskets of sand carried on human shoulders disappeared from the scene, and were replaced by M.M. Borel and Lavally, and M. Couvreux, contractors, with steam instead of human power.

M. Couvreux contracted for the enlargement to its full destined width and depth of the cutting of the El Guisr. Messrs. Borel, Lavally, and Co. undertook the remainder of the work. The modes of carrying out the works adopted by Messrs. Borel and Lavally are shown in the great model in the centre of the room. The model on the left bank of the canal shows the mode of disposing of the sand dredged from the bed of the canal—by tipping the dredge-buckets direct into a long shoot which leads inshore from the top of the dredge-frame. This shoot is inclined towards the shore at a gradient sufficiently quick to enable the silt charged with water to flow along it. The discharge is assisted by pumping water into the dredge end of the shoot by means of two rotary pumps worked by the engine of the dredger, supplemented, in case the nature of the silt requires further liquefaction, by a second pump placed upon the barge, and worked by a portable steam engine. The descent of the silt is further helped by scrapers, fitting the concave surface of the shoot, attached to endless chains passing over pulleys fixed at each end of the shoot. These scrapers

are also driven by the dredger engine. These shoots are 230ft. long; their section is a semi-ellipse, 5ft. wide, and 2ft. deep. They rest upon a pair of lattice girders, which latter are carried by an upright iron framing, standing upon a barge moored inshore of and parallel to the dredger. Lateral and vertical play is allowed for in the attachment of the shoot to the top of the frame of the dredger, and to the frame carried by the barge. The dredger engine is a direct acting, double cylinder, condensing engine of 35 horse power (nominal). The gradient of the shoot is varied to suit the description of the silt dredged. To discharge fine sand a fall of 1 in 20 is sufficiently steep, but the pumps have to supply a volume of water equal to half the sand; with clay a fall of 1 in 12 is necessary, but less water suffices. The mode of disposal above described is the most expeditious and economical in use on the works; it is applied in all cases where the height of the bank is not too great. Each dredger and shoot is calculated to dispose of about 1,200 cubic yards per day.

Where the banks are too high to be commanded by the shoot, another apparatus is used—the "Appareil Elevateur," a model of which is shown upon the left bank of the canal. This apparatus is designed to lift trucks full of sand from barges and run them to the tip inshore; it consists of two parallel lattice girders, extending from a barge moored to the shore, in a direction parallel to the canal, carrying upon their upper edges a tramway, which rises shorewards at a gradient of about 1 in 6; the lower end of these girders is about 10ft. above the level of the water, the shore or higher end 46ft. This frame is supported at two points, about 14ft. apart—viz., one on a barge moored close alongshore, the other on a platform carriage on the shore. Sufficient preponderance is given to the canal end to support the shore end, together with the weight of a full wagon. Very considerable ingenuity is exhibited in the arrangement of the framing, and in its attachment at its points of support, so as to render it sufficiently flexible to be non-susceptible of injury from the rolling of the barge, whilst its strength is sufficient to carry the weight of the full trucks running over it. On the tramway runs a carriage, consisting of two pairs of flange wheels and axles, kept about 4ft. apart by means of two horizontal pieces resembling the fiddle-sticks of a tip wagon; the wheels are keyed to the hinder axle; they run loose on the fore axle. To this carriage is slung the sand-truck, and it is the vehicle by which the latter is carried inshore. The fore axle of the platform carriage is thickened between the wheels, so as to form two drums of different diameters; to the lesser of these is attached a rope, which lifts the sand-trucks from the barge, and to the larger a second rope is attached, which passes over a pulley-wheel at the shore end of the tramway, and which draws the full wagons up the incline from the barge. The working is as follows:—The sand, which has been shot by the steam dredger into boxes resembling ordinary tip wagons, containing about 3yds. cube, is carried by a barge to the lower extremity of the elevator; a tackle attached to the small drum above described is hooked on to rings in the side of the wagon; the wagon, thus slung to the platform carriage, is hoisted by the engine to a height sufficient to allow of two small truck wheels, which are attached to the hinder end of the wagon, being engaged in the metals of a second tramroad placed below, and for five-sixths of its length parallel to the first. The engine, by pulling over the pulley-wheels, drags the carriage up the incline to the shore end of the elevator. The discharge of the contents of the sand wagon is managed in the following way:—As has been already stated, the upper and lower tramways are laid parallel to each other throughout about five-sixths of their lengths. At the shore end, however, they converge, the gradient of the lower tramway, on which run the small truck wheels of the sand-wagon, being considerably steepened; the hinder part of the wagon is thus borne up, whilst the forward, or tip end, is thrown down, so that the catch of the tailboard being disengaged the contents are shot. The empty truck then runs down the incline, is lowered into the barge, and a full one picked up. There are at present eighteen of these elevators at work; each of them takes two of the large dredgers to feed it.

M. Couvreux has employed an apparatus termed a dry dredger in the enlargement and deepening of the great cutting of El Guis. The apparatus consists of a platform carriage 20ft. long by 10ft. wide, mounted upon nine wheels, running on a three-rail tramway. On this is a steam-engine driving a chain of dredge buckets, which mount a jib projecting perpendicularly from the platform carriage, and which tip their contents into sets of earth-wagons which run upon a second tramway parallel to the first. The trains of sand-wagons are then run to tip by a locomotive. Each of the dry dredgers shifts about 900 yards cube per day of loose fine sand. The soil met with in the line of excavation for the canal is chiefly sand, river mud, and clay. A vein of rock crossing the ridge of Chalouf, about 3ft. above the canal bed, is the only excavation which requires blasting.

A very considerable work in connection with the undertaking of M. Lesseps has been the construction of Port Saïd, the Mediterranean harbour of the canal. This port is formed by two breakwaters running out a considerable distance into the sea; their shore ends being 4,592ft. and their sea ends 2,296ft. apart. The west breakwater is 10,168ft. in length; the east 5,000ft. Their upper surface is 17ft. wide, their sides batter 1 to 1 to the base. The harbour inclosed by these breakwaters is being dredged out to a uniform depth of 30ft. The material used in their construction is concrete blocks composed of sand and ground lime of Theil (from Ardèche, in France), the proportions being one of lime to four and a half of sand. The works of Port Saïd are being carried out by MM. Dussand, who have already constructed, with the same material, breakwaters at Marseilles, Cherbourg, and Alger. MM. Borel and Lavally have guaranteed the completion of their works on Oct. 1, 1869.

The great work, of which the above is a very brief and imperfect sketch, will well repay an attentive study. There is no country so directly interested in its success as England, the mistress of India. Hitherto it has been the fashion to consign the Suez Canal to the limbo of great impracticable schemes; we venture to think that amongst the many doubting Englishmen who have visited the models in the Paris Exhibition, and have been induced to inform themselves of what had been done and is doing, there are not a few who will have their scepticism in the feasibility of the scheme somewhat shaken.

America exhibits but few specimens of her engineering skill, and respecting those few it was by no means easy to obtain much detailed information.

A bold engineering scheme for the supply of water to the city of Chicago, in Illinois, is recorded upon a plan hanging against the west wall in the United States section, numbered 7 in general catalogue.

Chicago, the capital of Illinois, is situated upon the great lake of Michigan, whence it derives its supply of water.

The pollution of the water near the shore proceeding from the discharge of the town drains, &c., rendered it necessary that the supply for the use of the town should be drawn from a considerable distance out in the lake, and with this view a shaft consisting of cast-iron pipes 9ft. diameter and $9\frac{1}{4}$in. thick (in seven lengths of 9ft. each) was sunk from the surface of the water, two miles from shore, to about 35ft. beneath the bed of the lake. The depth of the lake is here about 28ft.

The part of this pipe which extends from beneath the level of the bed of the lake to its greatest depth is cased with brickwork in cement. The part of the pipe which stands in the water is protected from the action of the waves by a breakwater built round it in the form of a pentagon. This breakwater is a strong wooden framing, filled in with coarse concrete or rubble masonry. From the lower extremity of this shaft, 63ft. below the surface of the lake, a circular tunnel, lined with brickwork, in cement, 5ft. in diameter in the clear, and two miles in length, is driven beneath the bed of the lake towards the town, where it meets a second vertical shaft sunk within the shore line. This latter communicates through a chamber containing five wrought-iron regulating sluice gates, with a reservoir from which, by means of a large pair of pumping engines driven by steam-power, the water is lifted to a water tower 120ft. high, and distributed all over the town. A legend on the plan states that the work is the design of Mr. Coote, and that it has been three years in construction.

A good example of the ingenious application of wood to bridge construction, for which America is famous, will be found in a model 1-40th full size of a wooden railway swing-bridge which has recently been constructed in the State of Ohio. Timber bridges are specially suited to a new country where timber is cheap, and where it has been necessary to open up a new country rapidly and economically. These structures are, however, to be considered as essentially temporary in their character, and are generally built with a view to their being replaced at some future time in some more durable material. The bridge exhibited here is of a larger span than usual in designs of this class. Each opening has a clear span 150ft.; the diameter of turn-table is 33ft.; length of bridge over all, 335ft.; the depth of the truss is 10ft. at the ends, 34ft. at the centre. The arched part is composed of four timbers, 10in. by $6\frac{1}{2}$in.; main struts, 14in. by 8in., extend to each side from the turn-table to give support to the arched top, which is further strengthened by three straining pieces 8in. by 10in. The chord consists of four 12in. by $6\frac{1}{2}$in. timbers, and is put together with a camber of about 6in. The weight of the bridge is 200 tons.

Within the space to which it is necessary to restrict this memorandum it has been impossible to do more than briefly to call attention to a few of the most noteworthy exhibits. It will be seen that, though the progress of civil engineering has not been fully represented, no country having put forth its strength but France, there is still much exhibited that is interesting and instructive.

MODELS OF SHIPS AND LIFE-BOATS, CLASS 66, IN THE PARIS EXHIBITION.

By Charles W. Merrifield, F.R.S., Principal of the Royal School of Naval Architecture and Marine Engineering.

(*Continued from p.* 222.)

In compliance with the instructions which I have received, I have prepared my report with a view to its being a popular explanation of the exhibition of the models of ships and life-boats, and of the principles which they are intended to elucidate, rather than a record of the exhibits.

Two leading features distinguish the present exhibition of naval architecture from all previous exhibitions—the almost universal adoption of armour-plating for ships of war, and of steam propulsion for vessels of commerce. With the exception of a few yachts, there is very little representation of the class of sailing vessels.

The Governments of France and England have been careful to send very complete series of models of their fleets. England has sent by far the greater number of models; but the French models are fully rigged, while the English Admiralty has only sent half-block models. These contain a useful lesson to the naval architect, while they are somewhat too technical for the general public. Many of the large shipbuilding firms have also contributed models of existing vessels and designs for new ones; among the former are to be found many of the iron-clads of foreign countries. The United States of America have sent no models of their monitors. The visitors may, however, see what this type of vessel is from a model exhibited among the Russian ships.

As regards sea-going ships of war, the chief points of interest to the observer will naturally be the comparison of the English and French navies on the one hand, and of the turret and broadside systems on the other. The materials for the comparison might have been considered as very complete, but for the remarkable gap caused by the absence of any representative of Ericcson's monitors. The French Marine and the English Admiralty illustrate almost all possible broadside arrangements; while the models exhibited by Messrs. Laird and Co., of Birkenhead, and Messrs. Napier, of Glasgow, with a few more built by Messrs. Samuda and others, afford a very complete view of the turret system of Captain Cowper Coles.

The guiding idea of the French seems to have been the construction of a uniform fleet or squadron, while that of the English seems rather to have been the production of the best individual vessels for fighting purposes. Accordingly, there is a far greater variety in the exhibition of English vessels; while the French seagoing fleet is sufficiently represented by three or four types, the difference from class to class being far less than with us. They claim the following advantages, that even granting (which they do not allow) that certain individual English vessels are superior to any in their navy, yet that their average performance is better than our average, and that their uniformity gives them a greater power of manœuvring together as a fleet. They also consider that their ships steer more easily than most of ours.

Besides this difference in the primary condition of the problem, there are certain secondary points which distinguish their system, and amongst these the chief is the invariable use of wood for the construction of the immersed portion of the hull. Their general type, then, is a short ship with a wooden hull, coppered on the outside, an armour-plated belt going round the whole load water-line of the ship for some distance both above and below, and, if the belt does not extend upwards to the waterway, a central battery of either one or two decks, also protected by armour-plating. The upper works, both forward and aft of the central protected portion, are of light iron plate, it being considered sufficient to protect them against the danger of taking fire, without any attempt to render them shotproof. The modern adoption of very heavy guns has obliged changes to be made in the detailed arrangements of the ships, but these are not such as to affect their seagoing qualities disadvantageously.

Artillery and steam-engines are the subject of separate reports, and I shall not presume to make any attempt at discussing these; but I find it necessary to allude to those points relating to them which affect the naval architect.

The heavy sea-service guns of the present day vary from the 9-in. gun, weighing 12 tons, and throwing a projectile of 250lb. with 43lb. of powder, at an initial velocity of 1,370ft. per second, to the 12-in. gun, weighing 23½ tons and throwing a projectile of 600lb. weight with 70lb. of powder, at an initial velocity of 1,240ft. per second. It is doubtful whether the larger gun will ever be used in the broadside. But the 12-ton gun necessitates very different arrangements on board a ship, both in respect of height between decks and of size of battery, than was necessary even for the old 68-pounder. The absolute length of the slides is 13ft., and a space of 25ft. from centre to centre between the ports, and a height of 7ft. at least between the surface of the main deck and the lower flange of the upper deck beam are needed to work these guns properly. The 23-ton gun would require about 30ft. between the ports, and nearly 9ft. between the decks. Guns, instead of being fixtures, require three different kinds of motion to be provided for:—

1. Elevation or depression, for which they pivot on their trunnions.
2. Running out and recoil: in the latter the carriage runs back on the slide, being governed by a compressor, which acts like a brake on a railway train.
3. Training (or directing the gun to right or left).—This is done by allowing the slide to traverse round a pivot fixed in or close to the port-sill. These three motions, and especially the third, are so much more compactly managed in the turret that a large gun does not run the same risk of breaking away as it does in the looser connection of the broadside arrangement. Some recent inventions allow the gun to be elevated or depressed about an imaginary point at the muzzle, instead of at the trunnion, thus enabling the port to be kept as small as possible, but requiring a greater height between decks. Two devices for this purpose, due to Captain Heathorn, will be seen in the case containing the great turret-ships in the English marine department. The plan has not hitherto been adopted in the Royal service.

Breech-loading would much facilitate the introduction of heavy guns into the broadside; but both the English and American Governments, after trial of the two systems, have reverted to the muzzle-loading for their heavy artillery. In this they have but repeated the experience of the early artillerists, for breech-loading weapons are nearly as old as gunpowder. It is just one of those things which has a natural attraction for inventors, but it does not appear that even the accuracy of modern mechanism has yet been able to produce heavy guns under this system, which may be relied upon both for safety to the gunners and for keeping in working order, with rapid firing and after protracted use.

The French Admiralty does not as yet exhibit any large naval gun, but there is one large cast-steel breech-loader among the iron manufactures exhibited by the firm of Peter Gaudet. The calibre is is 0·20 mêtre, or 8in., while its length is 5½ mêtre, or 18ft. Some of the large Prussian guns are of the same length, or longer. Such pieces are not adapted for the broadside except in the very largest ships.

It is obvious that, from a port in the side of a ship, a gun can only command a small arc of training. It cannot be fired in a line with the keel, or even nearly so. It is, in fact, only 30 deg. of training to the right or left that can be given in the ordinary case of a midship gun, and this is not without bevelling the edge of the armour-plate at the port in a dangerous manner. To obviate this is the object of what has been variously called the cupola or turret (*tourillon*). Its most direct and complete application is when a single turret is the only projection on an unincumbered deck. Its pair of guns then command the whole horizon. But the establishment of any fixed structure on its glacis, whether it be a mast, a funnel, a raised poop and forecastle, or even another turret, detracts from its perfection, and it thenceforward competes with other systems simply on a balance of advantages. Its characteristic merits are its extended arc of training and the facility that it affords for working the heaviest ordnance. Most of the vessels actually built on this system contain two cupolas or turrets, and one or two of them contain three, and even four. Many of them also carry raised poops and forecastles, and deckhouses; the tendency in the modern examples being to make the poop and forecastle very small, so as to allow of a fire either fore or aft within 10 deg. of the line of keel, and to keep the deckhouse so narrow as barely to cover the other turret. But the necessity of having a forestay and anchor gear forward, and steering gear aft, appears to have led to the general abandonment of an absolute end-on fire. To meet this, a system has been devised which is illustrated by a handsome set of models exhibited by Vice-Admiral Halsted. In consequence, however, of a wish expressed by that gentleman, I do not report upon them.

One of the chief defects of the turret system is the enormous displacement which it requires, ranging from 400 to 1,000 tons per gun, the higher limit being that to which modern ocean-going vessels appear to be tending.

The sea-going iron-plated ships exhibited by the French Government are the following:—

Gloire.—A wooden liner, cut down and armour-plated along the water-line, with a midship battery, also protected. Her length is 289½ft., giving a proportion of length to breadth very nearly as 4½ to 1. She has engines of 900 horse power (nominal), and has a speed of 13½ knots. Her plating is 4¾in. Displacement, 5,650 tons.

Flandre.—A more recent model on a nearly similar type, a trifle longer, and more heavily sparred. She has 6in. plating, and a speed of 14½ knots, with the same nominal horse power.

Solferino.—Plated round the water-line, and having a central battery with two decks, each carrying guns.

Alma—Corvette of 450 horse power, wooden hull, with 5¾in. armour plating round the water-line and central battery. Her upper works are all iron. She is not yet launched, but is expected to have a speed of 12½ knots.

Marengo.—This is a very different type from the others. She has a wooden hull with iron upper works and 8-in. armour plating; she is built for carrying twelve large guns. The armour-plating extends round the ship at the water-line; and there is a central battery which extends to the upper deck, and carries, above this deck and half engaged in the bulwarks, an open armour-plated turret at each corner of the protected battery. Each of these turrets carries a large pivot-gun, mounted en barbette, and capable of firing in the line of the keel, and there are four more heavy guns in each broadside. She is 280ft. long, with a breadth of 57ft. 6in., and an extreme draught

of 28ft. She has a balanced rudder, curved so as to leave room for the boss of the propeller. The rigging is not brought down to chain plates outside the vessel, but is kept some 5ft. or 6ft. in-board, so that a perfectly clean side is presented out-board. The rigging of the other vessels is brought to the inside of the bulwarks, instead of outside; but in the *Marengo* there is room to stow a boat between the shrouds and the bulwarks. Her great breadth, in proportion to her masting, enables this to be done without sacrificing the necessary slope of shrouds. They are all short ships, the *Marengo* being the only one in which the ratio of length to breadth exceeds 5 to 1, and that only by a small fraction. There is very little gripe or fore-foot to any of them; but there is a considerable difference of trim. Hence they steer without difficulty. Their bows in general have no hollow at the water-line, but run rather to a wedge than to a cusp. The point of the wedge is rounded off in consequence of the thick stem which they carry. The *Marengo* has a ram bow, while the *Gloire* and the *Flandre* have upright stems.

The French vessels of recent construction have their bulwarks loopholed, for musketry.

One of the most remarkable foreign models is the Spanish iron armour-plated screw steam-frigate *Numancia*, constructed by the Société des Forges et Chantiers de la Méditerranée.

Length	(mètres)	96·08	...	317 ft.
Breadth	,,	17·34	...	57 ft.
Depth in hold ...	,,	11·18	...	37 ft.
Draught of water	,,	8·33	...	27 ft. 4in.
Displacement ...	(tonneaux)	74·20	...	7303 tons English.
Height of port-sill	(mètres)	2·25	...	7 ft. 5 in.

She is iron built throughout, and has 5in. armour plate, with 16in. of teak backing from stem to stern, and from 7ft. 9in. below the waterline to the level of the upper deck. She is armed with forty 68-pounder guns. She is rigged as a French frigate of the second class, and her engine is of 1,000 (nominal) horse power. Her speed on her trial reached $13\frac{3}{4}$ knots. She was the first large armour-plated vessel in the Pacific. It will be observed that her stem is straight. She was built at La Seyne, near Toulon, in 1863 and 1864, in less than two years. Her screw is of uniform pitch, and gave small positive slip.

Models of the Prussian frigate *Wilhelm I.*, the Spanish frigate *Victoria*, and the *Sultan Mahmoud* are exhibited by the Thames Iron Company. They are completely armour-plated.

Several armour-plated frigates of the Italian navy are also exhibited by English and French firms. They are chiefly characterised by the excessive length of their spurs or rams.

The English Admiralty contribute a complete series of half-breadth models of all the types of ships introduced into the Royal Navy since the adoption of the screw-propeller. As the English catalogue contains very full details of each of them, I think it is better not to mention them *seriatim*, but to give a general view of the chief changes which have from time to time been made in the leading types.

It will be observed that they begin with wooden ships of the line, simply altered from the old class of sailing ships by their being lengthened so as to admit of their carrying the screw propeller and its attendant machinery, their armament being chiefly 32-pounders, with heavier guns on the lower deck, and occasionally heavy pivot-guns; none of these, however, exceeding the 95 cwt. 68-pounder. A general tendency to increase in size will be observed, especially in the case of heavy frigates, the largest and the last built of these being the *Orlando* and the *Mersey*, sister ships in all but their armament. They were of 1,000 horse-power, and had a speed of 13 knots. Their length was 300ft., their breadth 52ft., and the mean draught of water about 22ft. The *Orlando's* armament was thirty-eight 8in. guns, of 65cwt., on the main deck, and twelve 68-pounder pivot guns of 95cwt., on the upper deck. The *Mersey* had twenty-eight 10in. guns, of 84cwt., on the main deck, and twelve 68-pounder pivot-guns, of 95cwt., on the upper deck.

Another general feature to be noticed is the increase in the sharpness of the lines forward, and in the proportion of beam to depth and draught of water in the more modern vessels. In general, also, the lower deck port-sills are higher out of the water, there being, on the whole, an increase of absolute size of ship as well as of weight of armament.

We pass on from these to the armour-plated vessels. It would exceed the limits allowed me for this report to do more than point out the chief characteristics of some of the more remarkable ones. The *Warrior* is especially worthy of notice as being the first iron sea-going armour-plated ship built in this country. Her protection is central only, and the ends of the ship are wholly unprotected. The *Black Prince* was built on the same lines, and the *Achilles* on nearly similar ones; but the *Achilles* has complete protection round her water-line. All these vessels have nearly the same construction of frames, which is well exemplified in their midship section. The next class is that of the *Minotaur*, *Agincourt*, and *Northumberland*, which have complete protection, except at the bow. Their framing differs in some respects from that of the *Warrior*, but they have all a common feature in which they differ from the *Bellerophon* and other modern ships of very large size—namely, that their flotation depends upon a single thickness of bottom-plating. The three midship sections exhibited together are well worthy of attention. The *Bellerophon* section exhibits all the structural superiority over that of the *Warrior*, which might be expected from its being built after so much more extensive experience. It has not only the double bottom, but it is lighter in proportion both to its longitudinal and transverse strength, and it is of far cheaper construction and easier execution. On comparing it with the *Hercules*, we observe that a certain amount of strength of form has been sacrificed for other objects, the longitudinal bulkhead of the *Bellerophon* evidently contributing more to strength than the smaller one of the *Hercules*. This sacrifice of strength is practically of no importance, as there is enough and to spare in both. In the *Hercules* the object was to get an enormous increase in the thickness of the armour plate backing at the water-line; and this was accomplished by filling up the whole breadth of the wing passage with teak, the wing passage being, of course, kept small to prevent a needless increase of weight.

The *Bellerophon* is a ship which attracted a good deal of attention during the time it was in course of building. Its chief experimental importance was in the following respects:—Economy of structure, shortness of ship, combined with respectable speed, handiness and facility of steering both under sail and steam, and a heavy armament, with sufficient, although not complete protection. The most noticeable features in the model are the form of its bow and its balanced rudder. We shall revert to these points. The *Hercules* is chiefly remarkable for the very heavy armour plating and backing which it is to carry; and this, as well as the *Penelope*, *Pallas*, and *Research*, has the peculiarity of recessed ports, to allow increased training to some of the guns.

Among the vessels of the Royal Navy observable for peculiarity of form will be noticed the *Penelope* and *Vixen*, with twin screws and double sterns; and the *Waterwitch*, double ended, and with an hydraulic jet propeller. These are all broad, shallow vessels of moderate draught, chiefly for coast service.

We now come to the sea-going turret ships, *Monarch* and *Captain*; the former designed by the Comptroller's Department and the latter by Capt. Coles and Mr. Laird. It will be observed that neither of them has a direct fire in the line of the keel, and that, whatever their means of defence may be, they are enormous vessels compared with their means of attack.

There are several turret-vessels, like the *Scorpion* and the *Wyvern*, the *Prince Albert* and the *Royal Sovereign*, which are not seagoing ships in the ordinary sense, but are intended for coast defence. Among the broadside-ships exclusively designed for that purpose will be noticed the *Trusty* and the *Erebus*, representing two classes of floating batteries, built for the Crimean War, and now disused. The French also exhibit some nice specimens of harbour batteries and one very peculiar ram (*Taureau*, or *Bélier*), with extremely sloping sides and a single fixed turret firing two guns in a line with the keel. She is built to steam twelve knots an hour. The turret-ships exhibited by Messrs. Laird and Samuda, also belong to the class of coast defence and river service. Two very remarkable boats for this purpose are the armour-plated floating batteries, *Colombo* and *Cabral*, built by Messrs. Rennie for the Brazilian rivers. They are on the "box," or central-battery, system, with the stem and stern kept low, so as to admit of fore and aft fire.

The means of propulsion employed for the iron-clad ships-of-war is a matter of very great importance, and is fully exemplified in the different models, both as proposed and as actually carried out. There seems to be a general consent to give them what is called jury-rigging—that is to say, much shorter and slighter spars and smaller sails than would be used in sailing-ships of the same tonnage. The English Admiralty exhibits no rigged models; but the *Wilhelm I.* the *Sultan Mahmoud*, and the *Victoria*, fine vessels exhibited by the Thames Ironworks, will show the rigging usually adopted. The French navy is rigged on the same system, but with the precaution of keeping the standing rigging well in-board, by putting the chainplates in the deck inside the bulwarks instead of outside.

The Russian Government exhibits characteristic specimens of its modern vessels of war.

1. The iron-clad frigate *Sebastopol*.—The chief feature of this is the absence of a forecastle, in order to leave room for bow guns in the armour-plated battery.

2. *Smertch*, armour-plated, with two turrets, each mounting two guns. —No obstruction whatever to their fire, except what one turret offers to the other. She has twin screws.

3. *Latnick*. monitor, with a single turret mounting two guns. This is the only monitor in the Exhibition.

4. *Metrone Menia*, armour-plated battery or ram, calculated for a speed of nine or ten knots. She has a draught of 14ft. 6in. Rudder and screw completely protected by the overhanging of the stern. Stem and stern fall home very much above the water-line.

The Russian Government also exhibits a wooden steam-frigate and a wooden steam-clipper, or despatch-boat, the latter calculated for thirteen knots.

Austria exhibits the *Erzherzog Ferdinand Max*, an armour-plated vessel, which sunk the Italian iron-clad *Ré d'Italia*, at the battle of Lissa. She is armour-plated completely with 4¾in. plating.

America exhibits very little in the way of naval architecture.

There is ample illustration of the merchant and passenger steam service, both of England and France, and of steam yachts and transports. I cannot attempt to enumerate these, nor do I observe any such marked peculiarities as would justify me in selecting any of them for special remark. It appears to me that a marked improvement has taken place in the naval architecture of Europe, not so much in any one strong feature as in a general tendency to advance in the perfection of form, fitness, and convenience, and external beauty. There is much less of extravagance of design, or idea, whether displayed in form or mechanism, and much more practical appreciation of structural beauty than I have observed in previous exhibitions, or than is to be seen here in some of the older designs.

A very valuable historical series of models of merchant ships is contributed by Messrs. Normand, of Havre. I studied with great interest the way in which the progress of shipbuilding exhibited itself in the practice of an old-established house. We see here the gradual expansion in magnitude, and the steady gradation of form from the old model of 1735 to the newest types of the present day, not masked by the varying practice of different firms, but just as it imprinted itself on an establishment with traditions already settled.

The Danube Navigation Company sends a very fine collection of models of its paddle-wheel passenger steamers, cargo boats, cattle boats, and lighters They are very long and shallow.

Norway also contributes good models of the vessels built in the Bergen district by Mr. Jens Gran and Mr. Dekke.

Form of Ships.—Many theories have been advanced as to the forms best calculated for speed, for stability, for easy rolling, and for almost every conceivable quality or combination of qualities which a ship may be imagined to possess. Yet the actual design of a ship's lines has still to be done empirically. Our theories and our calculations give us limits only, not form; for this we are still dependent on taste and experieuce. Our science enables us to control and correct our result; but our theories are yet too crude for the pure application of any one of them to prodnce a good ship. But we have arrived at very good approximate theories, and although it is certain that no two naval architects would produce identical designs for the same object as they would on an exact theory, yet there is a very well settled type for most of the leading forms of vessels, from which few modern designers appear very much to depart.

For the large ocean-going steamer the midship section generally shows a flat floor, and a full, or even square bilge, with a high co-efficient of fineness. The length is seldom less than seven times the extreme breadth. On the water-line there is more or less of straight middle, as the necessities of the service appear to require. The horizontal sections of the bow are generally what are known as Scott Russell's wave-lines, but usually a little coaxed out of their extreme sharpness towards the stem. They are almost always kept hollow in English ships, but the constructors of the French navy do not believe in hollow lines, and make but little use of them. With regard to the bow sections on the body plan, a great uncertainty, which seems, at last, to show signs of settling into something definite, appears to have lately prevailed; and the recent history of this is very well elucidated in the Exhibition. The *Orlando* and *Mersey* frigates, the *Himalaya* troop ship, and her Majesty's yacht *Victoria and Albert*, and the armour-plated ship *Warrior*, are very good specimens of different kinds of bows with the cutwater or "fore-knee." Then come the *Achilles* and *Minotaur*, with bows very nearly vertical, but a slight projection of the stem near the water-line. We then come to what has been called the U bow, seen in the *Pallas, Bellerophon, Lord Clyde*, and *Amazon*. This had the advantage of giving a large displacement far forward, so that the weights at the bow were better water-borne than in ships with overhanging bows. But these vessels carry a large wave before them, which interferes with their speed, and is in other respects inconvenient. Accordingly, the more modern designs of the *Hercules* and the *Monarch* have nearly vertical bows. The stem projects as a ram, but immediately behind the stem the bow is vertical, the bulwark acquiring a little flare as we go back towards the cathead, and then again becoming vertical before it begins to tumble home in the neighbourhood of the midship section. The U bow will be seen in excessive development in some of the foreign navies, as in the *Maria Pia*, exhibited by the Compagnie des Forges et Chantiers de la Méditerranée, and in some of the armour-plated vessels specially constructed as mere rams.

The bows of the *Solferino* and *Marengo* (French Imperial Navy) are worth special study. They are rams, and they secure a large displacement forward by falling home, above and below, from a point considerably below the water-line. But this object is attained in a way quite different to the U bow as seen in the *Pallas*, the fore foot being very much rounded off in the *Solferino*, and cut away so as to form a re-entering curve in the *Marengo*, so as in both to leave as little gripe as possible. The French ships are generally short, and have a considerable difference of draught, as is also the case with the *Pallas*, the *Favourite*, the *Bellerophon*, and the *Hercules*.

Sterns of modern ships are generally constructed with a much finer run than was usual in former times. It is also usual in iron-clad ships to make their horizontal sections, at and above the water-line, in the form of an ogival or Gothic arch, instead of the elliptical or square forms seen in merchant ships and transports; the object, of course, being to get more complete protection for the screw and rudder, without too great resistance or weight. In the case of twin screw-ships of large size, like the *Penelope*, there are two distinct sterns, oue carrying each screw, with separate deadwood and rudder, the space between being arched over. There is thus a considerable length aft but very imperfectly waterborue.

The upper works of ships exhibit a far greater variety than the underwater body, their design receiving but very few limitations from the hydraulic problem. The modern tendency has, perhaps, been to keep them too low both in armour-plated men-of-war and in cargo vessels. The top-gallant poop has long since disappeared, and a flush-deck is quite common, with sometimes a small poop and an open forecastle. In passenger vessels a spar-deck, or a long deck-house, extending from the poop to the forecastle, and leaving a long gangway on each side from 5ft to 8ft. broad along the middle portion of the ship, seems likely to become the normal type for sea-going steamers. This has the advantage that there is less broken surface, which is better for strength, and also as offering less resistance to the air. This consideratiou is too ofteu overlooked, although it is one of great importance when a vessel has to be driven at high speed in any direction but that of the wind.

Several specimens of the saloon ship are exhibited, and Messrs. Randolph and Elder have a model of one of the fine steamers they have constructed for the Pacific, with two ranges of saloons, one over the other, above the true upper deck of the ship. In the stormy waters of the Atlantic such vessels, although freely used by the Americans, do not find favour with the English, who regard them as inconvenient, if not dangerous.

Composite Ships.—Lloyd's Registry contributes a very fine series of drawings elucidating their proposed suggestions for composite vessels. The principle chiefly apparent in it is to secure a cage, or skeleton, of iron, complete in itself in every respect but that of keeping out water. The wood planking then converts it into a ship. The principle involved in this is very important, and depends on the observation that iron and wood together are not generally to be depended upon for helping one another to meet a single strain beyond the strength of whichever of them is separately the strongest. Each material, therefore, must be kept to its own work. Besides this principle, there is a vast amount of minute structural detail iuvolved in the compilation of such a set of rules as have already beeu adopted by Lloyd's and other registries for wood and iron vessels separately, and are now proposed for composite ships.

Bolts for Armour-plating.—Armour-plates and ordnance belong to a different class, which I have not been charged to report upon; but the mode of fastening it on is a part of shipbuilding, and the bolts adopted by the French are worth noticing. The hull of their vessels being of wood without any inner lining, there is no proper bed for a nut and bolt. They therefore use wrought-iron screws, which simply hold in the wood like common carpenter's screws. They have a small raised thread forged on them with a pitch of about ¾in., and consequently a flat space of about ½in. between the consecutive turns. It is not turned, but forged with an anvil and a hammer, having each three turns of the screw, the workman who holds the bar giving it a slight twist at each blow. The longitudinal fibre of the iron is thus unbroken, as M. Tresca has shown by oxydising a section of such a screw. The French officers speak very highly of their holding power.

Sheathing.—Several methods of sheathing iron ships are exhibited, involving three or four different principles. It may be premised that the object of sheathing an iron ship is not, as many suppose, to prevent general corrosion, but to prevent fouling. Now, copper, and, in a less degree, yellow metal, has this quality—that instead of corroding unevenly like iron, it goes almost uniformly over the whole surface, and that the salts formed by the action of the sea-water are soluble, so that it remains constantly smooth and slippery. It is this peculiarity, and not its poisonous character, that prevents seaweed and marine animals from adhering to it for, when protected galvanically, it fouls as quickly a

iron, wood, or stone. Many inventors have therefore endeavoured to find some means of getting copper on to an iron ship in such a manner that the iron shall be effectually insulated from it, and not form a voltaic couple, which would protect it at the expense of the iron. In the English annexe, Mr. J. H. Ritchie, jun., Mr. Mulley, and Mr. James show different methods of effecting this. Captain Roux, of the French navy, also exhibits a very elaborate process for the same result. The *Inconstant*, exhibited by the Admiralty, is another experiment in this direction. The object in them all is to secure complete insulation between the copper and the iron, and also to keep the iron completely covered up by the sheathing. They are all very expensive methods, and complicated, too; and they have all this disadvantage, that any external injury which exposes the iron and breaks the insulation, causes rapid local corrosion, so as to eat holes in the ship's side in a very short time.

Mr. Daft takes an opposite method: he sheathes with zinc, so that the voltaic action of the iron may cause this sheathing to undergo regular corrosion, like that of copper on a wooden ship. He exhibits experimental specimens by which its effect may be seen. His mode of putting on the sheathing involves a curious change in the present method of constructing iron ships which will certainly hinder its immediate adoption. Mr. Hay and Mr. Gisborne exhibit paints or compositions to prevent fouling and corrosion.

(*To be continued.*)

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ON THE IRON AND STEEL AT THE PARIS EXHIBITION.

At the recent meeting of the British Association at Dundee, Mr. John Fernie, of Leeds, spoke on the above subject before the Mechanical Section. He remarked that much had been said about the advance of French manufacture in this department as compared with the English. But such ideas would be dispelled by taking into consideration the effect of the protective tariff of the French customs, which interferes with our exports to France, and lessens the inducement for English manufacturers to exhibit their products in Paris. Mr. Fernie stated that the protective duties apply principally to manufactured iron, while coal and pig iron enter duty free; and the British department of the Paris Exhibition contained accordingly scarcely anything but the products of some Yorkshire houses who carry on some trade with France on account of the high quality and reputation of their products. In the French department some specimens of rolled iron had attracted much attention, since they were of a section far larger than any similar girders ever rolled in this country. The largest section was a double T exhibited by the Forges of Chautillon and Commentry; and next to those came some girders made by Messrs. Petin, Gaudet, of St. Etienne. Girders of that description had been made in England before this, and used for iron-plated ships; but the mode of manufacture was different, the girders being rolled as two simple T irons, and welded together in the web. The girders now made in France, on the contrary, are rolled in one piece from a single pile. These girders were very short comparatively with their other dimensions, and their manufacture should therefore be considered as a *tour de force* rather than as a practically useful innovation. In the manufacture of such girders, there was a large surface exposed, first to the action of the fire in the furnace, and then to the process of rolling, which was likely to deteriorate the iron. Consequently, even though this process was one which could be successfully adopted, there would be considerable doubt as to whether the strength of the girder made in this way would be equal to a girder made in the ordinary way—of boiler plate rivetted together. These girders, in the opinion of Mr. Fernie, had been made for the purpose of going beyond the English people, and not so much for their practical value. Another novelty was the process of stamping, lately introduced, and which has been very largely carried out by the French. This process was to make a complicated forging in small pieces fixed together, putting it in the furnace, raising it to a welding heat, and then completing the whole in a pair of dies by means of a few blows from a powerful hammer. This process had not come much into use in this country; but one English house had shown several specimens quite equal in manufacture to those exhibited by the French. The manufacture of steel in large masses, exhibited by Krupp and the Bochum Company, far exceeded in size anything as yet manufactured in England. The specimens from the Bochum Company were, in the opinion of Mr. Fernie, deserving of special mention. Twenty-two railway wheels of cast steel, all in one piece, and a still more beautiful casting of a locomotive cylinder were the finest steel castings ever exhibited. So far as France is concerned, England had not been excelled in any department in the manufacture of iron.

Professor Rankine wished to know by what process steel was manufactured at the Bochum Company.

Mr. Fernie said he believed it was by the crucible process.

Mr. Ferdinand Kohn said he had been in Paris a considerable time, and had directed his attention specially to the iron department; and having had a conversation with the manager of the Bochum Company, he could state that the Bochum steel was not manufactured by the ordinary crucible process. The mode of manufacture was a secret, but he believed that the process consisted in the casting of material containing a greater quantity of carbon than steel, and afterwards subjecting these castings to a process of decarburization.

Mr. Fernie, in answer to a question put to him by Mr. P. Le Neve Foster, stated that the reason why an order had been given by the Great Eastern Railway Company to a French house to make forty locomotives was in consequence of the English locomotive makers having more orders than they could execute at the time. Now, however, there was an immense number of new houses, and the old firms, having added new branches to their businesses, he did not think that in future English orders would require to be given to foreign companies to execute.

On Iron and Steel in the Paris Exhibition.

By Mr. Ferdinand Kohn.

In the discussion which followed Mr. Fernie's interesting paper on "Iron and Steel in the Paris Exhibition," the president of this section did me the honour to address to me a question about the processes now followed in this country and abroad in manufacturing steel castings and castings of malleable iron. Considering the importance of this subject, and the great variety of such processes now in existence and in practice, I did not, at that moment, think myself sufficiently prepared to address this section, but I proposed to draw up a few notes on that subject and upon some others closely connected with it. Having done so in the short space of time afforded me, and almost entirely from memory, I do not venture to bring this communication forward in the form of a complete paper, but I present it as an addition to the valuable paper read by Mr. Fernie a few days ago.

The collection of iron and steel at the Paris Exhibition is one of the most complete and instructive representations of the present state of iron metallurgy in all its branches which could have been brought together at any one spot under any circumstances. The rapid progress which the science and practice of iron and steel manufacture have made during the last few years, and the state of transition into which the whole iron industry of the world has been placed in consequence of these great and sweeping innovations, are the natural causes which made the display of iron and steel on this occasion more than usually desirable to exhibitors and attractive to the professional visitors.

I commence with the main cause of the great industrial revolution which we now witness, an invention with which the British Association has a historical connection, viz., the Bessemer process. The importance and extent which the Bessemer process has acquired during the eleven years of its existence I cannot better illustrate than by quoting an approximate estimate of the present rate of production of Bessemer steel, and of the productive power of the existing Bessemer steel plant in the different countries. My quotation is from a report made to the Austrian Government by Professor Tunner, one of the greatest authorities on metallurgy on the Continent, and one of the jurors in the iron and steel department at the Paris Exhibition. According to Professor Tunner's estimate, there are now in England fifty-two converters in operation, capable of producing, collectively, 6,000 tons of steel per week. Prussia has twenty-four converters, with a capability of make equal to 1,460 tons; France, with twelve converters in operation, can produce 880 tons; in Austria fourteen vessels can turn out 650 tons; and Sweden, with fifteen vessels, has a productive capability of 530 tons per week. There are two converters at Seraing, in Belgium, and two more in Italy, also one or two in Russia, making the the total power of production now available for Bessemer steel making in Europe equal to about 475,000 tons per annum. To this we must add America, with at least 50,000 tons, giving a total exceeding half a million tons of steel. The actual production of this present year does not of course come up to this figure; but it is, in all probability, considerably above 200,000 tons. In this estimate we find England's power of production fully twice as great as that of the rest of the world put together, and its actual manufacture of steel follows very nearly the same proportion. English Bessemer steel is not very well represented at Paris, but that purely accidental circumstance cannot mislead the judgment of anybody who is at all acquainted with the standing of this article in the markets of the world, with the quality of steel now turned out by the Bessemer steel works of this country, and with the extent of the trade done by them. The finest specimens of Bessemer steel exhibited at Paris are those made at Neuberg Works, in Austria, and at Fagersta, in Sweden. In both these works the raw materials consist of the purest ores known in Europe. The ores are smelted with charcoal, and the liquid iron is run from the blast furnaces direct into the converters; no spiegeleisen is required, but simply a small quantity of liquid iron from the same furnaces is used for adding the requisite carbon after complete decarburisation of each charge. In these localities, the Bessemer process exists in the ideal form in which it was first imagined by its inventor, but which Mr. Bessemer himself has been obliged to modify in order to make it suit the inferior qualities of ore existing in this country. That he has been eminently successful in this respect may be inferred from the fact that English hematite iron is exported in large quantities to the Continent, and used by steel-makers in France and in Germany in preference to the iron made in their own respective localities.

I now come to those much-admired steel castings of Rhenish Prussia which raise so much interest and curiosity, both by their extraordinary sizes and qualities, and by the secrecy and mystification which surrounds their manufacture. Prussia is a country practically without any patent laws. Inventors therefore are at war with society there, and that war manifests itself by the closed doors of all great industrial establishments, and by an amount of jealousy with regard to technical information which is entirely unknown in any other place. This explains the position of those celebrated steel-makers, like F. Krupp, the Bochum Company, and some others, who have succeeded in making important improvements in steel manufacture, and are now obliged in self-defence to protect their mental property from piracy in this barbaric manner. I have already stated it as a suggestion that the steel castings of the Bochum. Works may have been produced by running into the moulds a metal which con-

tains more carbon than steel, and is, in fact, cast iron, and by subjecting the finished casting to a subsequent process of decarbonisation. There are many other steel-makers who make use of a similar process for obtaining sound malleable castings of great strength. The process of making malleable cast iron long practised in England consisted in surrounding the cast iron with a quantity of pure iron ore, or oxide of iron, and exposing it to a high temperature for a length of time which was proportionate to the thickness of the mass of cast iron. By this process of cementation carbon was removed from the metal, and combined with the oxygen contained in the ore. This process is necessarily imperfect, since carbon is not the only impurity contained in cast iron, and the majority of the other elements is left in the mass. It has been, therefore, found necessary to use exclusively charcoal iron made with cold blast for this process, since this material contains less impurities and a smaller percentage of silicium than coke iron.

An improvement upon this process is that now practised by Messrs. McHaffie, Forsyth, and Co., in Glasgow. This, I understand, to consist in melting hematite iron in a cupola with some addition, the composition of which is kept a secret. The iron, when cast, is very hard, white, and brittle, but after decarburisation it very much resembles cast steel in all its properties. According to this description of the process, I should suppose that the admixture in the cupola may principally consist of an oxide of manganese,* which would deprive the iron of a part of its silicium, and thereby make it more suitable for being converted into steel by cementation. Still it remains doubtful whether any amount of admixtures will sufficiently purify the iron in the cupola for producing good steel by cementation, and the inferior tenacity of that material, to which Professor Rankine referred a few days ago, seems to be due to this cause. One of the most scientific methods of producing steel castings is that invented by M. Pierre Martin, of Sireuil, in France. M. Martin melts pig iron of a good quality, such as is used in the Bessemer process, in a Siemens furnace. He works at a very high temperature, and, by the action of a slightly oxidising flame upon the surface of the iron, succeeds in removing the silicon and other impurities from the iron, leaving only an excess of carbon in the liquid mass. This is then tapped from the furnace and cast. The castings, after being sufficiently cooled, are placed in another Siemen's furnace, having a lower temperature and a flame slightly overcharged with gas. This flame effects the process of cementation in a very perfect and uniform manner, the carbon of the iron being taken up by a part of the carbonic acid contained in the flame. As the process continues, the temperature of the furnace is raised, the flame being always maintained in its neutral character to prevent oxidation of the surface of the metal by the action of free oxygen. After a certain time, which depends on the thickness of the article operated upon, the process of cementation is completed, and the casting converted into steel. M. Martin has exhibited some very fine castings of that kind at Paris, and his process attracts a great deal of attention on the part of steel-makers. Messrs. Emile and Pierre Martin have also introduced another new steel process, which is now making rapid progress in France under the name of the Martin process. This consists in melting pig iron in the Siemens furnace, as described before, and in adding to the molten mass a suitable proportion of wrought iron, steel or pure iron ore; a process patented and described long before this by several inventors, but never as yet practically and successfully carried out. The Martin process, as far as is known at present, is a practical success. It has been recently introduced in several of the largest establishments in France—the Creusot works amongst these—and it is working to satisfaction everywhere. The principal advantage of this process consists in the facility which it affords for using up old iron and converting it into steel.

I have only to mention one more new process for making steel represented in Paris. This is a recent invention made by Mr. Siemens, and consists in making steel direct from the ore in a regenerative gas furnace. Mr. Siemens has exhibited a model of his proposed furnace, and a small piece of steel made by his new process, showing that his experiments have been so far successful.

In concluding these notes I wish to make a few remarks upon that vague notion now existing in this country, that the superiority and predominance of British iron manufacture had ceased to exist, or that it was threatened to be overthrown in the future by Continental competition. There are certainly no indications of such a state of things in the Paris Exhibition. If we look at the elements upon which all iron industry is based, we find British coal, although rising in price, still cheaper and better than that of most other countries, we find British hematite and other ores of similar purity abundant in this country, in close proximity to the great coal districts, while the French are importing iron ores from Elba, Sardinia, and even from Africa, and the Swedes and Austrians, who have good ores, are restricted to use charcoal as their fuel. With regard to the better qualities of iron, this country has, therefore, an advantage over all other iron manufacturing localities in the first cost of materials, which cannot fail to secure its superiority for some time to come. Equally so are the districts which produce the cheapest kinds of iron capable of holding their position in the markets of the world against anything that has been produced on the Continent, or shown in this Exhibition. From the finest Styrian Bessemer steel down to the cheapest rolled iron made in the Saar district of Prussia, or in Belgian ironworks, there is nothing which can compete with British iron in the long run. Krupp's steel is the only article, perhaps, that makes an exception; but this has been so for a long time past, and it is, therefore, no more likely now to interfere with the general superiority of British iron manufactures than it did many years ago.

Having yesterday heard the very valuable and interesting report presented to this section by Dr. Fairbairn, I desire to add a few remarks with regard to some tests of iron and steel which I have noticed in the Paris Exhibition. There are many fractured steel bars of varying degrees of hardness exhibited by different parties, and in all these a striking resemblance presents itself with regard to the appearance of the lines of rupture. These fibres in tension break in a straight line, while in that portion of the bar where the fibres are compressed, a wedge-shaped piece (Fig. 1) is forced out. The shape of this wedge

FIG: 1.

and the relative position of the point where its two sides meet, and which point seems to represent the neutral fibre of the bar, appears in all specimens to be strictly dependent upon the degree of hardness of the steel. The tests in which this is most prominently shown are those made by Mr. David Kirkaldy for the Fagersta Works, in Sweden; and these are all the more instructive, since the exact chemical analysis—so far as contents of carbon are concerned—is given with each specimen. It is clearly visible that the point representing the neutral fibre lies nearer to the line, *a b* (or top flange), in the harder specimens, and it descends towards the line, *c d* (or bottom flange) in the specimens of a softer kind, until at last, in the softest specimens, the wedge disappears altogether, since they double up without fracture. This seems to indicate a varying proportion of tensile and compressive strength in steel of different degrees of hardness, which will be best illustrated by a kind of diagram (see Fig 2). Suppose

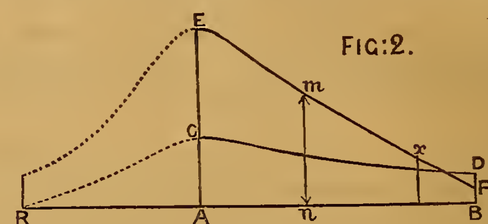

FIG: 2.

the datum line, A B, to be graduated in the divisions corresponding to decreasing percentage of carbon in the steel, and the line, A C, to be proportionate to the tensile strength of the hardest steel, then the decrease in tensile strength with decreasing contents of carbon will be represented by a curve, C D, the law of which has, of course, not been ascertained as yet. If, further, A E represents the strength of the same hardest specimen of steel in compression, it seems from what has been observed hitherto, and also to some extent from Dr. Fairbairn's tables, that the line, E F, which represents the decrease of strength in compression in softer steel, will fall more rapidly than the first, and ultimately cross C D, so that for wrought iron, which must be supposed to be the last element of this series, the resistance to compression will be only half that which is offered to a tensile strain. The softest kinds of steel now in use seem to range somewhere about the point where the two lines cross each other, while in the hardest kinds it appears that the strength in compression may be about three times as great as that in tension. I think, therefore, that it would not be advisable for engineers to rely in all cases upon the average proportion arrived at by Dr. Fairbairn, and which is expressed in his abstract of results, viz., that the strength of steel in compression is about double its tensile strength. This proportion seems to be correct only for those kinds of steel which on the diagram represent the medium quality of the specimens tested, and might be represented by the line *m n*. With regard to some of the softest specimens of steel, which, according to Dr. Fairbairn's tables, have given the highest results, I wish to draw attention to the fact that these specimens come from two different makers, viz., Messrs. Cammell and Company, and Messrs. H. Bessemer and Company. These specimens appear to be Bessemer steel of that quality usually made for boiler plates. I can find no better proof of the scientific perfection and reliability of the Bessemer process as practised in England, than the close correspondence of the results obtained with these samples. There are two different establishments having no connection with each other, entirely independent in their practical management; they both make a certain quality of steel to be used for boiler plates, and the results shown by their products under the test are so nearly alike, both in tensile and in compressive strength, as to fall almost within the limits of observation.

The President said he quite concurred with the author of the paper in his remarks on the patent laws. He instanced the reaping machine invented by Mr. Bell, which he said, was, in consequence of no patent having been taken out for it, allowed to lie over a long time. Had Mr. Bell taken out a patent, some of the agricultural implement manufacturers would have taken to the invention, and the country would have had the benefit of its excellent qualities twenty or thirty years sooner. With regard to the diagram illustrating the relative proportions of tensile and compressive strength of different kinds of steel, he thought the curves, if continued on the other side, so as to represent iron with a greater percentage of carbon, would follow a course as indicated by the dotted lines, C R and E N, and the line R N would then represent grey cast iron, the tensile strength of which is below that of wrought iron. The strength in compression would fall less rapidly, as indicated by the curve, E N. This would then complete the diagram for the entire range now in existence between cast iron on one side and wrought iron, in which the percentage of carbon comes down to zero on the other side. He concluded by stating that the idea of constructing such curves was very useful, and that in future such curves should be constructed from the data already in existence in the reports and tables.

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* This has since been denied by Messrs. McHaffie.—ED. ARTIZAN.

ON A TOURIST INDICATOR.

By Mr. Bazalgette, C.E.

The difficulty of obtaining local information after reaching the summits of eminences from which extensive views are obtained, the author believes, is experienced by all classes of tourists. To provide for such want, and to supply reliable topographical information, the author proposes that local indicators should be placed upon summits which are periodically visited by tourists. The local indicator would consist of a circular table of stone or metal engraved with radial lines pointing in the direction of any object of interest. Upon the line would be engraved the name of the object, its distance from the point of view, and in the case of mountains, giving their correct height above the sea. A table of 3ft. in diameter would be sufficiently large to embrace a district of thirty miles in radius, which would generally be found sufficient. To facilitate reference, concentric lines at distances of five miles would be engraved upon the table, within which circles the names of places at such distances would appear. Upon an outer circle the names, directions, and distances of large cities, cathedrals, dockyards, headlands, and other objects of interest, beyond the thirty mile circle would be shown. In the centre of the table may be placed a telescope with an indicating hand, arranged so that on placing the hand in the direction of any object, the object itself, if within the range of sight, would be brought within the field of the telescope. The telescope would be removable, unless in cases where it might be deemed advisable to cover in the table with a light ornamental building, which would also serve as a shelter for visitors. Arrangements are now being made by the author for the erection of a local indicator with a telescope and light ornamental shelter upon the summit of the Malvern Beacon-hill, in Worcestershire. This hill is at an elevation of nearly 1,500ft. above the level of the sea, and commands a complete panorama of the richest and most beautiful scenery, limited only in extent by the powers of sight. The form of the local indicator may be varied according to circumstances. It may be cheaply constructed in cast iron, and with or without the telescope and building. The local indicator would afford to the tourist much of the interest and information which is frequently lost in consequence of fogs enveloping the summit which with difficulty he has reached, and would at once point out the direction for returning—a want which the author has frequently experienced. If carefully constructed the indicator would supply the tourist with reliable information, and at once afford ready answers to most of the questions relating to the neighbourhood, which usually elicit the stereotyped "I don't know," or incorrect and worse than useless "information" commonly obtained from so-called guides. A smaller and less complicated form of indicator would be found useful in open places in large towns—the direction and distances to churches, railway stations, theatres, &c., being given. The tops of letter pillar-boxes being provided with such information would assist strangers, and even residents as to distances and cab fares. The author thanked the meeting for the attention with which they had listened to his description, and said that he felt some apology was almost necessary for occupying the time of such a meeting with a subject apparently so simple, were it not that its very simplicity constituted one of its great merits, for, while it was intelligible to, and would afford instruction to, persons of the humblest amount of education, it might still be a source of interest, amusement, and information to those of the highest attainments.

ON STEAM CULTIVATION—THE ADVANTAGES TO BE DERIVED FROM IT, ITS PRESENT POSITION, AND FUTURE DEVELOPMENT.

By Mr. David Greig.

It is not my intention in this paper to treat of the mechanical part of the above subject; for although the greatly varying nature of the soils and circumstances to be dealt with all over the country render it necessary to have many different adaptations of the apparatus employed, still the machinery has now been so nearly brought to perfection that the farmer has no longer any difficulty in obtaining apparatus suited to his own particular requirements. The means employed to bring about such results as those to which the writer will advert can scarcely be considered of that importance which the subject assumed during the earlier stages in the development of steam cultivation. The points the writer proposes to deal with are:—The advantages to be derived by the farmer from the use of steam, in the shape of better crops; tillage operations more economically effected; the lessening of the number of operations required, and, most important of all, work done at precisely the right time, and when it can be done to the greatest advantage. I shall also advert to the present state of steam cultivation and its prospects for the future.

It is asserted by all who have tried spade husbandry that the crops obtained under that system are much better than those which can be got from horse-cultivated land; indeed, this is so far the case, that although to cultivate land by the spade a foot deep costs £4 per acre, it would pay the farmer better to employ the spade than the horse, providing the necessary amount of manual labour could be procured at the proper time. The state of the labour market in England, however, renders such a system of cultivation impracticable; but the superiority of the spade to the plough remains an indisputable fact. The chief feature of advantage in spade husbandry is the thorough loosening and mixing of the soil, and as this is much better accomplished by steam, it logically follows that crops upon steam-tilled land will be far superior to those grown under horse culture; and this is borne out by actual experience, the exchange of horse for steam power being generally followed by a marked improvement in the crops and much greater yield per acre, varying, of course, with the nature of the soil, but amounting in some cases to two quarters more corn per acre. Ample proof of the accuracy of this statement may be found in the recently published "Reports of the Royal Agricultural Society's Commission on Steam Cultivation," a work with which I presume most gentlemen are well acquainted. The reason for this increased productiveness can be easily understood. A team of four horses ploughing a 12in. furrow will leave more than 300,000 footprints per acre; and as these nearly cover the ground, the effect, as every farmer well knows, is to leave a hard subsoil, or "pan," beneath the cultivated ground, which becomes worse with every successive ploughing at the same depth. The tractive power that horses are able to exercise upon a plough or other implement is very limited, and is further decreased in consequence of having to convey their own weight over the broken and uneven soil, and also to partly undo the compression caused by the treading of their feet.

"If a horse be taken when the land is in a rather plastic state, and walked across the track of the steam plough, and made to travel to and fro transversely on every 10in. width until a breadth of six yards is trodden over, it is then found that if the steam cultivator has just sufficient steam to perform its work properly before it arrives at the ground so trodden down it will be completely stopped before it gets through the six yards; and, considering the momentum of the fly-wheel, this experiment shows plainly that the power required is something very material; and experience shows one-third additional draught to be required on land that has been trodden down to the same extent as in cultivation by horse-power."

With steam the case is very different. The engine stands on the headland and hauls the implement to and fro by means of a wire rope; all treading and compression of the soil and subsoil is thereby entirely avoided, and the implement is driven at a much more rapid pace, throwing up the soil to a greater depth and in a loose state, enabling it to derive full benefit from the influences of the atmosphere.

It is found in practice that the rapid motion of the steam-driven implement tends to loosen and ærate the soil much below the actual depth at which the tine or share is running. In horse or ox ploughing the case is just the reverse, as the sole of the plough and the treading of the animals so consolidate the bottom that the necessary chemical action between soil and subsoil is prevented, and, consequently, all escape of gas and water. The result of the deep tearing up and loosening of the soil at the proper time by steam is that its temperature is raised and a much greater quantity of ground is penetrated by air. The air is replaced in the same proportion by water when rain comes, and this moisture is retained in the cultivated ground as though in a sponge, any superfluous quantity sinking away to the drains beneath, instead of the whole lying for some time on a hard trampled subsoil as though held in a dish, making the land cold and ungenial.

I am now more particularly referring to heavy land, but a similar result is observable in the case of light land. Light lands are never much damaged by wet, the principal danger is from "burning" in dry weather, but the deep cultivation and loosening of the soil (instead of having it lying on what might be termed a "board") causes even light land to retain its moisture in a dry season for a considerable time. The mere question of ærating the soil deserves much more attention than is generally given to it.

Mr. Bailey Denton lately wrote an able letter to the *Times*, which forcibly illustrates the importance of this question. He says:—"Within a few miles of the metropolis, in North Park Farm, Blackheath, Mr. Shepherd has raised a breadth of wheat which any earnest agriculturist will be pleased to see. It is growing on land not naturally fertile, which Mr. Shephard underdrained at his own cost, and has since cultivated with Fowler's steam plough. The yield has been estimated by good judges at an average of forty-five bushels per acre. At 8s. per bushel this will bring £18 per acre, irrespective of the straw, which may be considered as equivalent to the harvest expenses. Adjoining North Park Farm is some very good wheat growing on similar land equally well drained and treated, except in the one particular of steam cultivation. It has been horse-ploughed. This yield may be fairly put at thirty bushels, which, at the same price per bushel, will bring £12 per acre. Within sight of these two instances may be seen some wheat also growing on land similar in character to Mr. Shepherd's, which has neither been drained nor steam-cultivated, the yield of which cannot be estimated at more than twenty bushels to the acre. The return in money at the same price per bushel will be £8 per acre. Hence we have within a short drive of London three cases for comparison, which cannot fail to show that by the adoption of deep steam cultivation on deep drainage the produce of our stiff soils may be doubled." But steam cultivation improves the crops in another way. If the soil has been thoroughly and deeply loosened at the right period, and has not been consolidated except by its own weight, the roots of the plants have ample liberty to penetrate until they are stopped by natural causes. In dry seasons the roots are thus enabled to follow the moisture in the ground very much further than would otherwise be possible, and as no burning can take place until the deepest root has entirely exhausted the moisture around it, the crop is made capable of resisting the effects of drought for a very long time. The writer believes that the success or otherwise of a crop depends upon the number of cubic feet of soil that the roots are able to penetrate, and the writer has found that a grain crop will stand up much better, and is not so easily laid on a deeply cultivated soil as on one that is shallow. From what has been said on this part of the subject it will, the writer thinks, be readily conceded that a great improvement in the crops is one of the results that must inevitably follow the use of steam on the land.

At the present time the cost of performing tillage operations by steam is very far from being so low as it should be, or what it eventually will be. In many cases, and especially with machinery working for hire, the very heaviest portion of the work is given to steam, and generally that which cannot well be done by horses. Now, before we can obtain the maximum of cheapness we must cause steam power to perform all the operations connected with the tillage of the ground. For, if after steam ploughing a field, horses are taken upon it, perhaps two or three times for the purpose of harrowing or doing other similar work, the ground is of course trodden down and consolidated again. The consequence is that the next year it requires much more power to break it up than would otherwise be the case, and not only does it require this extra force, but clod-

crushers and other implements have to be applied to it, which would not be required if the treading were avoided. The generality of land if put under steam cultivation and kept entirely free from the trampling of animals, would only require one very deep cultivating operation every fourth or fifth year, and would be kept in such a state as to allow air and moisture and the roots of the crop to penetrate freely, so that the cultivation for the grain crops in the rotation would only require to be light or surface operations sufficient to receive and cover the seed. The cost of steam cultivation has hitherto been greatly increased by the excessive breakages that have occurred to the machinery. These have arisen from two causes, namely, the want of men properly educated to the work, and the deficient construction of the machinery at first employed. The varying circumstances under which the apparatus had to work involved much more experimenting to bring it to perfection than would have been the case with any fixed machinery. These difficulties are now, however, altogether overcome, and with ordinary good management any mishaps of the kind named may be wholly avoided.

With regard to the cost of steam as compared with horses, the writer finds from careful observation that, including interest on money, depreciation, and repairs, the average yearly cost of maintaining a set of steam cultivating machinery, doing 2,000 acres per year (say 10in. to 12in. deep), is under £300, or 3s. per acre. This allows money enough for its replacement in ten years. A good machine of this kind should displace over thirty horses, and of course many horse implements. Now the wear and tear of the harness, implements, and the amount of farriers' and other bills in connection with these thirty horses, with interest and depreciation, will be at least twice as great as the corresponding items chargeable upon the steam tackle. The average price of coals per horse-power per day—that is, the cost of the quantity of coals we should have to burn in an engine to get out of it work equal to what one horse could do in a day—is 7d. It is quite evident that the daily keep of a horse is much more than this. Less than half the number of men also are required to do the same acreage of work, although their wages have to be somewhat higher than those of the ordinary farm labourer. Or, to put the case more concisely: a pair of horses in an ordinary plough cannot pull with a force of more than 3cwt. or 4cwt. at the most, and a day of this work cannot cost less than 10s.; on the other hand a steam ploughing engine will give off during the whole day eight or nine times that draught, at a cost of certainly not more than £3. These calculations are per day only; but as the horses have to be kept and fed when they are idle as well as when they are working—which is not the case with the steam engine—the comparison is manifestly unfair to the latter. The whole of the comparison should be based on a yearly average; but it is rather difficult to come to a conclusion how many acres a pair of horses can cultivate in a year, even supposing them to be exclusively occupied in such work. But money is saved in another way. After a thorough deep ploughing or cultivating by means of steam, it is evident that only half the number of after operations will be required to bring the ground to a tilth. In heavy land twitch will be found to disappear altogether, as there will be no treading and plaiting of it by the horses' feet, which has so much effect in undoing the very operation while being performed, and consequently, necessitating many successive operations in thoroughly clearing the land. A steam-driven implement always tends to bring the weeds and rubbish to the top, never buries them. Heavy land is not naturally inclined to grow twitch; and if so, much treading and trampling should be prevented. It is the writer's firm opinion that no such thing would grow on it, except through gross mismanagement or very light crops. The want of suitable implements has been a drawback to the cheap use of steam in tillage, as farmers have not been able to effect more than a portion of their work by its means.

(To be Continued.)

ON THE CONSUMPTION OF FUEL.

By Mr. Wm. Patterson, C.E., Perth.

The consumption of fuel in the furnaces of land and marine engine boilers, in the best way possible, so that the heat evolved during combustion may be utilised to its fullest extent, has become a question of the deepest importance, since steam power has supplanted nearly all other motive powers, in moving the machinery used in arts and manufactures, propelling vessels, and drawing carriages, and is otherwise extensively used in heating and drying processes. According to Sir Robert Murchison's report as to the coal produce of foreign countries and England, it appears that the produce of England is 98,150,587 tons per annum, and as there is no doubt but that a small proportion of that quantity only will be used for domestic purposes, it is therefore no wonder that the exhaustion of our coal fields is apprehended, and although the industry of the country cannot be stinted in its supply of coal, in order to the conservation of such a valuable article, the next best thing to do is to take all the heat out of the fuel that can be got by proper combustion, and to apply the heat so obtained so as to raise the largest quantity of steam at the most economical pressure for working with, and thereby obtain the greatest amount of work from the least quantity of coal, and thereby limit the demand and save money on what is burnt; and as the product of proper combustion is a colourless vapour, the annoyance of having the atmosphere of towns impregnated with black smoke or unconsumed carbon would be avoided.

Although it is apparent from the chimneys of furnaces of some works and vessels not emitting much coloured vapour, that the consumption of fuel is pretty well performed, but whether economically or not cannot be said; it is, however, equally apparent by the issuing of black smoke or unconsumed fuel from among many of the chimneys in our manufacturing towns, collieries, and steam vessels, that economy in the consumption of fuel is not yet generally obtained, and "that the time has not arrived when it would be considered a disgrace to produce black smoke."

Notwithstanding that several treatises on the proper consumption of fuel and the prevention of smoke have been published—one of the best of which, with supplement by W. Fairbairn, Esq., C.E., appeared in the printed transactions of this Association—but of these treatises there is in some of them too much stress laid on, and argumentation in favour of, some particular view the writer held, or patent he had some pecuniary interest in, which militated against the real essential part of the work, and in all, even the best, the information given is of rather too scientific and technical a nature, and practical directions are so far wanting as in a great measure to prevent practical men from understanding and applying the information therein afforded.

It therefore occurred to me to make an attempt to supply what is required, and having no further interest to serve than the advancement of science in this direction, I, in no controversial spirit have put together such practical observations, suggestions, and rules as may conduce to that end, which, from the experience and observation of thirty years, I have learned and found to be efficacious in consuming fuel by proper combustion and applying the heat so obtained, and I trust that the present attempt will not altogether prove useless.

To have fuel properly consumed, and the heat evolved therefrom utilised to its fullest extent, we must have the area of the fire grate of a size capable of holding the weight of fuel of the necessary depth sufficient to raise the steam required, the depth or thickness of fuel on the grate, bars, or branders being in proportion to the quantity of air that can pass through between the bars and fuel at the rate necessary for perfect combustion in connection with the method adopted for feeding the furnaces, and the flues and chimney must be so proportioned to the area of fire grate that the products of combustion shall be carried away at such a rate that a sufficient supply of air may be obtained and be under control at the furnace. The second object is obtained by causing the flame or heat arising from the incandescent fuel to be applied to as large a surface of the boiler as can be got at when the heat is at the greatest, and the heated air or products of combustion may leave the boiler at the same temperature at which the steam is in the boiler, the boiler being of a form that in the circumstances offers the largest absorbing surface to the heated products of the fuel, formed of the best conducting materials, having the least possible quantity of water in the boiler that is necessary for the steam required, accompanied with a sufficient steam space. To arrive at the proper area of fire grate it is necessary to know the kind of fuel that is to be burnt thereon and the quantity of steam that has to be obtained from the boiler.

There have been published several excellent analyses of the different kinds of fuel used, but all that is really required may be obtained by consulting the tables* given in the excellent reports of "Experimental Investigation on Coals for the Steam Navy," by Sir Henry de la Beche and Dr. Lyon Playfair, and with the tables in these reports will I principally deal in illustrating the process of arriving at the respective areas from fire grate to chimney, and will take of the tabulated fuels in the reports mentioned the Newcastle Hartley and Fordel splint, and for 100lbs. each.

1. To find the cubic feet of oxygen necessary to saturate the carbon of the fuel take the per centage of carbon, opposite the fuel selected in column B, table II.; multiply it by 2·666, the atomic weight of oxygen that combines with one of carbon, and by 11·85, the number of cubic feet in 1lb. of oxygen; the product is the cubic feet of oxygen required.

Newcastle Hartley. (Per cent. of carbon 81·81.)	*Fordel Splint.* (Per cent. of carbon 79·58.)
81·81	79·58
2·666	2·666
218·105	212·150
11·85	11·85
2584·544 cubic feet of oxygen required.	2513·977 cubic feet of oxygen required

2. To find the oxygen necessary to saturate the hydrogen of the fuel take the per centage of hydrogen opposite the fuel selected in column C, table II.; multiply it by 8, the atomic weight of oxygen that combines with one of hydrogen, and by 11·85, the number of cubic feet in 1lb. of oxygen; the product is the cubic feet of oxygen required.

Newcastle Hartley. (Per cent. of hydrogen, 5·50.)	*Fordel Splint.* (Per cent. of hydrogen, 5·50.)
5·50	5·50
8	8
44·00	44·00
11·85	11·85
521·40 cubic feet of oxygen required.	521·40 cubic feet of oxygen required.

3. To find the quantity of atmospheric air that will give off these two quantities of oxygen add the quantities of oxygen required for the carbon and hydrogen of the respective fuels together; multiply the sum by 4·762, the proportion in volume the atmospheric air bears to the oxygen in it; the product is the atmospheric air required. It may be necessary to mention here that to be strictly correct it would be necessary to deduct from the sum of the two quantities of cubic feet of oxygen the cubic feet of oxygen in the fuel, as shown by the per centage in column F., table II., but as it is uncertain at what time the oxygen is evolved from the fuel, and it is rather better to have an excess

* These tables are published separately by the Parliamentary Commission, or may be found in Lockwood's "Engineers' Pocket Book."—Ed. Artizan.

than a deficiency of oxygen, I considered it not necessary to take that into account.

Newcastle Hartley.	*Fordel Splint.*
2584·544 for carbon	2513·977 for carbon
521·400 for hydrogen	521·400 for hydrogen
3105·944	3035·377
4·762	4·762
14790·505 cubic feet of air required.	14454·465 cubic feet of air required.

4. To find the economic value or evaporating power of the selected fuel, take the number of pounds given in column A, table I, multiply them by 100, the product is the weight of water in pounds that 100lbs. of fuel will evaporate; then divide the last product by the rate of evaporation, column K, table I., the product will be the time in hours it would take to evaporate the weight of water which 100lbs of the fuel could evaporate.

Newcastle Hartley.

Water evaporated, 8·23lbs.; rate of evaporation, 308.

8·23
100

308)823(2·672 time required.

Fordel Splint.

Water evaporated, 7·56lbs.; rate of evaporation, 464·9.

7·56
100

464·9)756(1·626 time required.

5. To find the cubical content of 100lb. of the selected fuel when used as fuel, and the square area it will cover of fire grate in inches, at 12in. and 6in. deep, multiply 1728, the inches in a cubic foot of fuel, by 100, and divide the product by the number in Column B, Table I.; the quotient is the cubic inches in 100lb. of the fuel used as fuel; then divide the last result by 12, the square root of the quotient will be the side of the square in inches of area of the fire-grate, covered by the fuel in 100lb. at 12in. deep. For 6in., square the side found for 12in., double it, and the square root of the product is the side of the square area of fire-grate covered by 6in. of fuel. For 4in., triple it, and the square root of the product is the side of the square area of fire-grate covered by 4in. of fuel.

Newcastle Hartley.

Weight of coal as fuel 50·5.

1728
100

50·5)172800(3421·78
12)3421·78

$\sqrt{285\cdot148}$ = 16·886 side of square of 12in.
23·880 side of square of 6in.
29·247 side of square of 4in.

Fordel Splint.

Weight of cubic foot of coal as fuel, 55·0.

1728
100

55) 172800 (3141·818
12)3141·811

$\sqrt{261\cdot818}$ = 16·180 side of square of 12in.
22·883 side of square of 6in.
28·025 side of square of 4in.

6. To find the area in a cubic foot used as fuel to allow air to pass through different kinds of fuel, multiply 144, the number of inches in a square foot, by the number in Column B, Table I., the weight of a cubic foot of coal used as fuel, and divide the product by the number in Column C., Table I., the weight of a cubic foot of solid coal; subtract the quotient from 144, multiply the remainder by ·666, the square root of the product is the side of the square in inches of the air passage through a square foot of the selected fuel at the branders or fire-bars.

Newcastle Hartley.

Weight of cubic foot of coal used a fuel, 50·5; weight of cubic foot of solid coal 80·27.

144
50·5

80·27)7272(90·594 144

53·406
·666

$\sqrt{35\cdot568}$ = 5·963 side required.

Fordel Splint.

Weight of cubic foot used as fuel, 55·0; weight of cubic foot of solid coal, 71·61.

144
55

78·61)7920(100·75 144·00

43·25
·666

$\sqrt{21\cdot804}$ = 5·366 side required.

7. To find the rate at which the air must pass through the fire-grate to burn off the 100lb. of the selected fuel, divide the cubic feet of atmospheric air, found by Rule 3, by the time in seconds that 100lb. of fuel takes to evaporate the quantity of water found by Rule 4; multiply the quotient by the side of the square in inches of fire-grate found by Rule 5, and divide by the side of the square in inches of the air passage per square foot of fuel found by Rule 6, the quotient is the rate at which the air must pass through the fire-grate per second to burn off 100lb. of fuel at 12in. deep on bars; if for 6in., one-half; and if for 4in., at one-third of that rate.

Newcastle Hartley.	*Fordel Splint.*
2·672	2·672
60	60
160·32	160·32
60	60
9619·2(14790·505(1·537	9619·1(14454·465(1·502
16·886	16·180
5·963)25·953(4·352 } rate required.	5·336)24·302(4·554 } rate required.

To find the area of fire-grate, with the fuel at 6in. deep thereon to raise steam from 212 deg. equal to one nominal horse-power of a condensing engine, divide by 60 the pounds of water evaporated by 100lb. of fuel in an hour, as found by Rule 4, multiply the quotient by 27·648—the cubic inches of water in 1lb. of water; and by 1669—the cubic inches of steam in 1lb of water—at the pressure of the atmosphere, and by ten, the pounds of effective pressure the steam would have on the piston of a condensing engine having a good vacuum; divide the product by twelve, the quotient would be the number of pounds that could be raised by the steam 1ft. high in a minute; divide this by 44,000,* the quotient is the number of horses' power in the steam raised by 100lb. of fuel 6in. thick on the fire-grate, then by this number of horses' power, divide the area of fire-grate covered by fuel 6in. thick, as found by Rule 5, the square root of the quotient is the side of the square of area of fire-grate with the fuel of 6in. deep for a nominal horse-power of a condensing engine.

Newcastle Hartley.

Water evaporated, 8·23lb.

8·23
100

60) 823 (13·716
27·648

379·219
1669

632916·511 16·886
10 16·886

12)6329165·110 285·136
2

44000)527430·425(11·987)570·272($\sqrt{47\cdot574}$ = 6·897.

Fordel Splint.

Water evaporated, 7·56lb.

7·66
100

60) 756 (12·6
27·648

348.364
1669

581419 516 16·180
10 16·180

12) 5814195·160 261·792
2

44000)484516·263(11·011) 523·584 ($\sqrt{47\cdot545}$ = 6·895.

To find the area of fire-grate with fuel of 6in. deep for a nominal horse-power of a non-condensing engine, say at 30lb. effective pressure on the piston, which will

* This is the co-efficient given in Mr. Patterson's paper.

take steam of 50lb. pressure in the boiler. Divide by 60 the pounds of water evaporated by 100lb. of fuel in an hour, as found by Rule 4; multiply the quotient by 27·648—the cubic inches of water in 1lb. of water—and by 552, the cubic inches of steam in one of water at 50lb. pressure, and by 30, the pounds of effective pressure; divide the quotient by 12; the quotient is the number of pounds that can be raised by the steam 1ft. high in a minute, divide this by 44,000, the quotient is the number of nominal horses' power in the steam raised by 100lb. of fuel at 6in. in the fire-grate: then by this number of horses' power divide the area of fire-grate covered by fuel 6in. thick, as found by Rule 5. The quotient is the side of the square of area of fire-grate with fuel of 6in. thick thereon for one nominal horse-power of a non-condensing engine at 30lb. of effective pressure of steam.

Newcastle Hartley.

Water evaporated, 8·23lb.

8·23
100
60) 823 (13·716
27·648
379·219
552
209·328 16·886
30 16·886
285·136
12) 6279·866 2

44000)523·322(11·893)570.272($\sqrt[2]{47·950}$ = 6·924 side.

Fordel Splint.

Water evaporated, 7·56lb.

7·56
100
60) 756 (12·6
27·648
348·364
552 16·886
192296·928 16·886
30
285·136
12) 5768907·840 2

44000) 408742·320 (10·925) 570·272($\sqrt[2]{52·198}$ = 7·224 side.

The foregoing proportions of fire-grate, and the uniform rate of air passing through it into the furnace, would hold perfectly correct were the fuel supplied to the furnaces by machinery or self-feeding apparatus, so that a portion of the hydrogen of the fuel would be consumed along with the carbon of it, and if by the kind of feeding apparatus used the fresh fuel could be got under the incandescent fuel, then when the hydrogen from the fresh fuel obtained its proper proportion of the air passing through the fuel, the remaining portion of oxygen would combine with the carbon in a properly heated state, but if the furnace is stoked by hand then the rate at which the air must enter the furnace for proper combustion will not be uniform, being greatest when the hydrogen of the fuel is being evolved, diminishing as the hydrogen is burnt away, and the incandescent fuel becomes thinner and thinner on the fire-grate until the furnace is stoked again. It is found that the larger the percentage of hydrogen there is in fuel above 3½ per cent., so much the larger also is the carbon set free during the evolution of the hydrogen, and consequently the less percentage of coke left after the volatile products are consumed.

8. To find the time when the largest quantity of oxygen is required during the combustion of the fuel, assuming the rate of the consumption of carbon is at a uniform ratio, multiply the time in which 100lb. of fuel takes to evaporate the quantity of water found by Rule 4 by the number in Column H, Table II.; divide the product by the number in Column B, Table II., substract the quotient from the time first taken, the remainder is the time in which the carbon, volatilised by the hydrogen, must be consumed along with the hydrogen of the fuel.

Newcastle Hartley.

Per cent. of coke left, 64·61. Per cent. of carbon, 81·81.

2·672
64·61
2·672
81·81) 172·367 (2·110

·562 time required.

Fordel Splint.

Per cent. of coke left, 52·03. Per cent. of carbon, 79·58.

1·626
52·03
1·626
79·58) 84·600 (1·063

·563 time required.

9. To find the quantity of the atmospheric air to give off the oxygen required to saturate both the carbon and hydrogen evolved in the time found by Rule 8, subtract the number in column H, Table II., from the number in Column B, Table II., the remainder is the per cent. of carbon volatilised: multiply this by 2·666, as in Rule 1; to the product add the oxygen found by Rule 2, then multiply this sum by 4·762, as in Rule 3; the product is the quantity of atmospheric air to give off oxygen for the complete saturation of the carbon and hydrogen in the time found by Rule 8.

Newcastle Hartley.

Per cent. of coke left, 64·61. Per cent. of carbon, 81·81.

81·81
64·61
17·20
2·666
45.855
521·40
567·255
4·762
2701·268 quantity of air required.

Fordel Splint.

Per cent. of coke left, 52·03. Per cent. of carbon, 79·58.

79·58
52·03
27·55
2·666
73·448
521·40
594·848
4·762
2832·666 quantity of air required.

The time when smoke is emitted from the chimneys or funnels is when hydrogen is being evolved from the fuel during the combustion, and if a sufficient quantity of oxygen cannot be brought in contact with the products of the coal through the fire-grate at that time so as to fully saturate both hydrogen and carbon—hydrogen having a greater affinity for oxygen than carbon, and combining in combustion with it in a much colder state than carbon—lays hold, as it were, of its full equivalent of oxygen first, leaving the carbon set free by it to combine with the oxygen left, if any, in the proportions which produce carbonic oxide, which is emitted from the chimney as light brown smoke; and the heat evolved in the production of this oxide is not above two-fifths of the heat if the same amount of carbon had had its full equivalent of oxygen. For, although the heat evolved generally is in proportion to the oxygen burned, that law does not hold good in this case, and if little or no oxygen is left the free carbon goes off in the shape of black smoke, and no heat is obtained from the carbon—rather the reverse—it having carried away some of the heat evolved from the combustion of the hydrogen. The process used in the formation of lampblack is a good illustration of how black smoke is produced. In some instances there is not sufficient oxygen for the complete saturation of the hydrogen alone. In this case the unconsumed hydrogen goes off along with the carbon, and if the chimney or funnel be low will be observed burning in flame at the top. Instances of the latter kind occur when the combustion is slow; the distillation of the fuel goes on most favourably under slow combustion, the effect of which is that a great proportion of the oxygen of the atmospheric air gets into combination with the carbon at the top of the fire-bars, creating a strong heat there—in many cases melting the bars and roasting and distilling the fuel above, while the oxygen is being exhausted, the products of the distillation going off along with the carbonic acid gas or oxide, and nitrogen, the *rationale* of the process in such cases is that the oxygen burning the fuel, a small quantity of oxygen is consumed compared with the quantity of fuel, while in the cases where proper combustion takes place the largest amount possible of oxygen is consumed compared with the quanity of fuel. Although a great deal can be effected to remedy the unequal demands of atmospheric air in the furnaces that are stoked by hand by a judicious method of stoking, Mr. Watt instituted a very good system of having an extra depth of fuel placed at the furnace mouth, partly on the dead plate, so that by a partial distillation some of the more volatile products are brought off slowly and are burnt off along with the incandescent fuel on the area of the grate, that extra thickness at firing being spread over the reduced depth of the fire-grate, and the principal part of the fresh fuel being as before laid at the furnace mouth; still it is clear that a regular and uniform supply of air into furnaces is not required for complete and economic combustion when the feeding of the furnaces is done by hand: therefore, when the largest quantity of air required cannot be brought through the fire-bars, the additional supply can be very well supplied through apertures having regulators on them in the furnace doors, or if the furnace or fire-grate is long, a supply can be obtained through or at the back of the bridge or flame-wall, the air being conveyed to the bridge in a pipe or pipes having regulators on them. These regulators could be wrought with self-acting cataracts in connection with the furnace doors. Ashpits should be in cross section the full aggregate area of

the open spaces between the fire-bars, and should have doors on them with slides to regulate the supply of air and act as dampers where the heat evolved requires to be retained for a short time. A sufficient cubic space above the fire-bars is of great importance to allow the volatile products of the fuel to be properly mixed and combined before being carried away over the flame-wall and forced in amongst the carbonic acid gas and nitrogen of the air consumed, as also to keep that part of the boiler over the furnace from being roasted, as it were, by being too near the incandescent fuel in a white heat. As an empirical rule I have found it answer very well to allow an average of two cubic feet above the fuel on every square foot of fire-grate; this, with the thickness of the fuel gives an average height the boiler ought to be above the fire-grate. I may remark here that it is always well to allow for a good thickness of fuel being used on the fire-grate, it being most economical for raising high-pressed steam, for, as it may be observed by comparing the sizes of fire-grates required for a nominal horse-power of a condensing and a non-condensing engine that they are nearly alike, it is therefore evident that working with high-pressed steam is the most economical, inasmuch as a small quantity of high-pressed steam having the same elastic power as a larger quantity of low-pressed steam, by being wrought expansively, will work with a useful effect two and a half times more than the low-pressed steam. Of the area over bridge or flame-wall, to insure proper combustion in the furnace, it is imperative that the products of combustion should not pass over the bridge or through the flues at a greater rate than the air comes through the grate-bars.

(To be continued.)

THE S.S "SUMATRA."

The splendid iron screw steamship *Sumatra*, built by Messrs. Wm. Denny and Brothers, and engined by Messrs. Denny and Co., for the Peninsular and Oriental Steam Navigation Company, having been thoroughly fitted up and equipped for sea, left the Gareloch for Southampton. The *Sumatra* is a vessel of 2,167 tons, being the last and largest, and, as has been proved, the fastest of the many fine steamers constructed by her builders prior to their removal to the more extensive premises which they now possess. The *Sumatra* is in many respects a sister ship to the *Bangalore*, recently supplied to the same owners by the Messrs. Denny, and which has lately made the quickest run from Gibraltar to Southampton ever made by any of the Peninsular and Oriental Company's steamers. Both ships are brig-rigged, with standing bowsprit and one funnel, and having the spar deck more than usually free from erections they possess more than most of steamers what sailors regard as a "ship-shape" look. The saloons are elegantly, but chastely, ornamented, the introduction of teak, zebra wood, and Hungarian ash in the mouldings and panelings giving a pleasing variety of colour, and harmonizing and contrasting well with the gilt cornices and white and gilt ceilings. The state rooms are fitted up handsomely and comfortably; and in every department of the ship the most effective appliances are introduced for the securing of that thorough ventilation which is so essential in the warm latitudes in which at times these ships will in all probability be employed. As we so recently described the *Bangalore* with some degree of minuteness, it is not necessary that we should do more in respect of the *Sumatra* than give a few of the principal facts and notice those points in which the latter differs from the former. The principal dimensions of the *Sumatra* are :—Length, 305ft.; breadth, 38ft.; and depth, 28½ft. The engines, by Messrs. Denny and Co., are of the inverted cylinder, direct-action kind, with surface condensers, and all the most recent improvements. The cylinders are 75in. in diameter, and the length of the stroke is 3ft. 9in. The nominal horse-power is 500, and the indicated horse-power 2,278. Steam is supplied by four tubular boilers, each with five furnaces, which are fired athwart ships. The *Sumatra's* passenger accommodation is amply sufficient for 111 first-class and 52 second-class passengers.

The official trial trip took place on the 24th Sept., when four runs were made at the measured mile on the Gareloch with the following results:— First run, with the wind, 4min. 5sec.; second run, against the wind, 4min. 46sec.; third run, with the wind, 3min. 59sec.; fourth run, against the wind, 4min. 47sec. Average of the four runs, 13.71 knots per hour.

HER MAJESTY'S SHIP "DANAE."

This vessel, which has attracted very considerable attention at Portsmouth Dockyard since her launch and during the subsequent time of her outfit for commission, and which went through her trials of speed, &c., at light immersion over the measured mile in Stoke's Bay, under the superintendence of Captain W. C. Chamberlain, commanding Her Majesty's ship Asia and the steam reserve of Portsmouth, is a vessel of 1,287 tons measurement, 21ft. in length between perpendiculars, and 36ft. in breadth. She will carry two 6½ ton 7in. rifled guns, and four of the rifled 64-pounders as her armament, and is propelled by engines of the new type of 350-horse power, nominal, working up to six-times their nominal rate. The cylinders have a diameter of 64in., and a stroke of 33in. The engines, as regard their general arrangements, are of the usual double connecting-rod type, but possess this peculiarity, that they are fitted with only one condenser, one air pump, and one circulating pump. These pumps being driven, one from the piston of each engine. The circulating is of the same size as the air pump, and is so arranged that by simply opening a valve it can at once be made use of as an air pump to work in conjunction with the other, when it is desired from any cause to work the engines by the ordinary system of injection condensation, or *vice versa*. By this arrangement, the advantages of surface condensation are attained without any addition to the working parts of the engine. The condenser tubes are of brass, placed horizontally, and have the condensing water circulated through their interior. The boilers are four in number, with a total of fourteen furnaces, an aggregate grate area of 260 square feet, and a heating surface of 6,800 square feet. The screw is a two-bladed Griffiths, having a diameter of 15ft., and set at a pitch of 15ft. 6in. Messrs. J. Napier and Sons, of Glasgow, are the makers of the engines, and the admirable manner in which the latter did their work reflected great credit on the engineering talent of the firm. On the *Danae* leaving Portsmouth harbour for the trial waters in Stokes Bay, her draught of water was 12ft. 5in. forward, and 15ft. 8in. aft, giving a mean draught of 14ft. and half an inch, the immersion of the upper edge of the upper screw blade above the water being 2½in., and the area of midship section 380 square feet. This was a mean immersion of the ships hull therefore, of about one foot less than it will be at her load draught, her designed draught then being 13ft. 6in. forward, and 16ft. 6in. aft. At her previous draught her area of midship section was as nearly as possible 380 square feet. Two hundred and forty tons of coal were on board, twenty-one tons of which were of the steam navigation (Nixon's) description to burn on the trial. The coal bunkers of the ship, it may be remarked here, have a stowage capacity of 230 tons. The trials from first to last were carried out without the slightest hitch of any kind with the machinery with the following satisfactory result :—

Six Runs with Full-Boiler Power.

Ship's speed.	Steam Pressure.	Vacuum.	Engine Revolutions.
knots.	lb.	in.	
13·846	31	27	97·62
12·996	29	26·5	96·62
14·062	29	26	96·10
12·587	29	26·5	95·46
14·118	28	26·5	94·82
12·371	29	27	96·08

Mean speed of the ship under full-boiler power, 13·384 knots per hour.

Four Runs with Half-Boiler Power.

Ship's speed.	Steam Pressure.	Vacuum.	Engine Revolutions.
knots.	lb.	in.	
13·231	29	26·5	75·44
9·230	29	27·5	77·23
13·333	29	27	76·66
9·184	29	26	77·45

Mean speed of the ship under half-boiler power, 11·262 knots per hour.

In testing the working of the engines to order by mechanical telegraph from the deck bridge to the engine-room, they were stopped dead from going ahead at full speed in eleven seconds; started again to full speed ahead, from a state of rest, in four seconds; and reversed from full speed ahead to full speed astern in thirteen seconds. The engines worked magnificently, and the boilers had an ample supply of steam.

The *Danae* will most probably prove to be the fastest vessel of the improved Amazon type yet sent afloat, when she has all her weights on board, as is in every respect complete for sea service. She will also possess excellent accommodation for her officers and crew, and will be a kind of ship that any one belonging to the naval service of the country in time of peace would be glad to have the opportunity of serving on board, especially on a foreign station. With these advantages added to the amount of success she has thus far attained at the measured mile and the anticipated thirteen-knot speed at her deep-draught trial, there is the certain danger so often experienced on previous occasions of the first trial of a vessel of the *Danae* type being very much over-estimated, and possibly raised to the dignity of a

kind of model vessel discovered lately and adapted to present requirements for reconstruction of the British navy The *Danae* is nothing of the kind. She is merely a descendant of the ill-fated Amazon, only that she is a trifle longer, and consequently a little larger in the tonnage than that vessel was, and has fine V in lieu of bluff U lines where her bow enters the water forward. The addition of a new steamship to the navy of this country necessarily represents a large expenditure of public money, and every ship thus added increases in total cost upon that of the previous vessel per gun carried. With the rapid progression of our ideas at the present moment towards power on all matters connected with a ship of war, this increase and costliness appears to be unavoidable, but it becomes at the same time an incontrovertible protest that any attempted descriptions or criticisms of these vessels shall only be made with such impartiality that their faults shall be as fully exposed as their virtues. If the *Danae* then is judged fairly in this spirit, she will most probably be pronounced to be the antithesis of a prodigy in either steaming power, beauty of form, or—more important than all—in fighting capacity, and is consequontly a dear vessel at the sum she has cost. First, as to her steaming powers. The measure of this must be obtained by comparison with other vessels, and the most reliable means for the purpose, and especially as defining the true or false form of the immersed portion of a ship's hull, as affecting hor speed under steam, is to weigh the exerted (indicated) powor of her engines against the area of the propelled ship's midship section and her gross measurement, the nominal power of the enginos being for the time put entirely out of court. Thus mainly confining considerations of the steaming powers of a ship to h e exerted power of the engines' weight moved, and speed obtainod in knots per hour, the subjoined table of results compiled from "The Trials of Her Majesty's Ships," published by tho Admiralty, tho dates of the trials extending over a period of upwards of six yoars, and including vossels of every class, from tho stately three-decker to the small screw sloop, will be found amply sufficient in its details to fix the exact valuc of the *Danæ's* spood under steam, and also to illustrato what progress has been made in the form of vessols designed by the present, over past schools of naval architecturo.

Name, and date of Trial.	Indicated horse power.	Tonnage.	Mean Draught of Water.		Area mid section.	Speed of Ship.
			ft.	in.	sq. ft.	knots.
Warrior, Oct. 17th, 1861 ...	5·469	6·039	26	0	1·219	14·356
Achilles, April 28th, 1864...	5·722	6·121	26	5	1·307	14·322
Duncan, Aug. 7th, 1860 ...	3·341	3·716	19	7	793	13·388
Orpheus, Dec. 4th, 1860 ...	1·445	1·702	15	3	443	12·449
Wolverine, Feb. 18th, 1864.	1·495	1·703	15	3½	448	12·545
Rattlesnake, Dec. 18th, 1861	1·798	1·705	15	1	437	13·023
Rinaldo, Aug. 9th, 1860 ...	749	516	11	10	278	8·238
Howe	4·524	4·236	21	7½	949	13·565
Danae	2·100	1·287	14	0¾	380	13·384

Remarks.

Warrior, 630 indicated horse-power exerted less than number of tons; measurement of ship's hull, or 5,496 indicated horse-power, driving 1·219 square feet of midship-section, 14·356 knots per hour.

Achilles, 399 indicated borse-power less than tonnage, or 5·722 indicated horse-power driving 6·121 squarc feet of mid-section, 14·322 knots.

Duncan, 375 indicated horse-power less than tonnage, or 3·341 indicated horse-power driving 793 square feet mid-section, 13·388 knots.

Orpheus, 257 indicated horse-power less than tonnage, or 1·445 indicated horse-power driving 443 square feet mid-section, 12·449 knots.

Wolverine, 280 indicated horse-power less than tonnage, or 1·495 indicated horse-power driving 448 square feet mid-section, 12·545 knots.

Rattlesnake, 93 indicated horse-power in excess of tonnage, or 1·798 indicated borse-power driving 437 square feet mid-section, 13·023 knots.

Rinaldo, 233 indicated horse-power in excess of tonnage, or 749 indicated horse-power driving 278 square feet mid-section, 8·238 knots.

Howe, 288 indicated horse-power in excess of tonnage, or 4·524 indicated horse-power driving 949 square fect mid-section, 13·565 knots.

Danae, 813 indicated borsc-power in excess of tonnage, or 2·100 indicated horse-power driving 380 square feet mid-section, 13·384 knots.

The indicated horse-power of the *Danae's* engines has not been worked out, but it is here taken at the power contracted for, and the figure is expected to be rather in excess of six times the nominal power. Next as to the beauty of form of a vessel's hull, this essential qualification is obtained, or generally supposed to be so, not by the meretricious aid of false fixings in the shape of figureheads and quarter-galleries, but by the lines of curvature of a vessel's hull above or below the line of immersion. Old ideas on this subject, however, are constantly being hustled by tbe phraseology of tbe day that "beauty must necessarily now be sacrificed to efficiency"; simple assertions are of no value unless backed by proofs, and in this case the proof seems to lie the contrary way. Taking the first of our ironclads—the *Warrior*—as an example of beauty of form, combined with a great carrying power and a high rate of speed, what vessel, as an ironclad, that we have since added to our navy in which the modern idea of the sacrifice of beauty to efficiency has been fully carried out can be said to surpass her even now, on all tbe points of her qualifications as a man-of-war?

Ths *Danae* herself, in tbe rebuilding of her force-body while on the stocks, and the substitution of fine for bluff lines at the bows, is a step backwards from ugliness to beauty. The change has not been made radical enough, however, and, altbough she stands a finger-post on the road, the *Danae* can never lay claim to being a handsome vessel, any more than she can to possessing a rate of speed due to the power of ber macbincry.

NOTES OF ENGINEERING, ETC., IN SCOTLAND.

Railway Improvement at Coatbridge.

The North British Railway Company's line at Sunnyside has lately undergone important changes. To suit the plan of the proposed new line to Glasgow the course of the line near the Sunnyside Station has been slightly changed, and for the purpose of doing away with the four level crossings over lines leading to the various works, two handsome iron bridges have been laid over the railway, and the roads leading to Gartsherrie and Cumbernauld have been carried over tbese bridges, and have thereby been widened and greatly improved. The bridges were built by Messrs. Blair and Gray, Clydesdale Iron Works, Glasgow, and are of a very substantial cbaracter. The crossing of the line at the station has been provided for by a handsome malleable iron stairway, erected by Messrs. P. and W. M'Lellan, Glasgow. The working of the linc has been made very efficient by tbe erection of new patent signals at various points, and the entire locality has been improved. We believe that a commodious new station for Sunnyside has been planned, and when it is completed the arrangements for passenger and traffic accommodation at Sunnyside will be satisfactory and serviceable.

Glasgow Public Library.

The annual meeting of the subscribers to the Glasgow Public Library was beld in the Library-rooms, Bath-street, on the evening of the 2nd ult., P. Salmon Faill, Esq., in the chair. Tbe Chairman congratulated the meeting on the progress of the library during the past year. It was shown by the report that upwards of 200 volumes had been added to the library since last October, tbat the number of readers had very greatly increased; and that, after payment of all expenses, a considerable balance was left in the treasurer's hands. It was remarked that a statement of affairs so gratifying had not for many years been made in behalf of this institution; and it was confidently believed that the efforts of the curators to place this library on a basis still more popular than heretofore would continue to be appreciated by the community at large. Special facilities had been afforded to commercial and public establishments in the city, and it was gratifying to state that tbe experiment of opening up the library to the wide circle of readers had operated very favourably.

The Philosophical Institution Edinburgh.

The arrangements of the institution for the coming session exhibit a brilliant array of lecturers and subjects. Mr. Lowe, M.P., is to deliver the opening address. Amongst the lecturers arc several who have not hitherto appeared:—Mr. Alexander Herschell, Sir David Wedderburn, Bart.; Mr. Bearington Atkinson, and Mr. Nathaniel Holmes, of London; and Mr. George Grieg, late of Marseilles; whilst of former lecturers there are Sir James Lacaita, Rev. Dr. Hanna, Professor Masson, Mr. George Dawson, Mr. Robert Carruthers, Dr. Page, Mr. George Baynham, and Dr. W. B. Hodgson. Two veteran citizens are also to appear as lecturers, namely, Mr. Adam Black and Dr. Wm. Graham—Mr. Black's topic being a "Visit to Spain," and Dr. Graham's, "Scottish Life in the Early Part of this Century." The various subjects of the lecturers seem to have been selected with much judgment, and the session has every prospect of being a successful one.

The Windmillcroft Dock, Glasgow.

On the 11th ult., the iron bridge which spans the entrance to the Windmillcroft Dock was swung round for the first time with complete success. The structure consists of three main longitudinal lattice garders, measuring 168ft. in length, by about 9ft. in depth. These are connected by cross beams, over which is laid a double roadway for carts and carriages, the extreme width of the bridge from side to side being 39ft. A passenger gangway, supported on substantial brackets, runs along each side of the

roadway, from which each gangway is separated by one of the lattice girders. The bridge is poised on a steel pivot, secured in massive masonry, on the east side of the dock entrance. The length on the west side of the pivot being greatly in excess of that on the east side, a counterpoise is provided in the shape of a mass of pig-iron. When in motion, the bridge is carried on a series of wheels, working on circular iron plates let into the masonry. The necessary motive power is supplied by a hydraulic engine with cylinders of 7¾in. diameter, and 18in. stroke. The bridge having been swung back, the deepening of the entrance will now be vigorously prosecuted, and it is expected that very shortly the basin will be opened for the reception of shipping.

Trial Trip of the "Commercio de Paysaudu."

On the 2nd ult., the *Commercio de Paysaudu*, twin-screw steamer, built by Messrs. A. and G. Inglis, was taken down the river for trial. The boisterous state of the weather rendered it impossible to run the course between Cloch and Cumbrae, and it was therefore determined to test the vessel's speed at the measured mile on the Gareloch. The results there obtained were considered highly satisfactory. the speed being nearly twelve miles per hour, with a moderate consumption of fuel and a remarkable absence of vibration.

Launch of the "Blonde" at Port Glasgow.

Messrs. Blackwood and Gordon launched, on the 27th of September, from their building yard a screw steamer of the following dimensions:—Length of keel and forerake, 150 feet; breadth of beam, 22 feet; depth of hold, 11 feet 6 inches; tonnage (builders' measure), 352 tons. On leaving the ways the steamer was named the *Blonde*. Immediately after the launch the *Blonde* was towed into the builders' dock alongside of their yard to receive her machinery, and she is now nearly finished for sea. The *Blonde* is built for Messrs. Weatherly and Mead, of London, to run in concert with the late Clyde steamer *Blanche* as pioneer steamers of the Anglo-French Screw Steamship Company, trading between London and Dunkirk.

Launch of the "Kinfauns Castle" at Overnewton.

Messrs. Charles Connell and Co. launched, on the 1st ult., from their yard a finely-modelled composite clipper ship of 920 tons (builders' measure), built to obtain Lloyd's highest class for composite ships. She was named the *Kinfauns Castle* as she left the ways. She has been built to the order of Messrs. Thomas Skinner and Co. for the East India trade, and is, we understand, the seventh ship built by Messrs. Connell for this firm.

Launch of the "Taraguy" at Whiteinch.

Messrs. Aitken and Mansel launched, on the 26th of September, a handsome twin-screw steamer of about 550 tons B M., her dimensions being 175ft. by 25ft. by 15ft. The *Taraguy*, as she was named by Mrs. Edward Arthur, of Bristol, and her sister vessel the *Goya*, have been built to the order of Messrs. James Dalglish and Co., of Liverpool, for the Parana Steam Navigation Company, Buenos Ayres, and have been constructed under the superintendence of Captain Hunter, the manager of the company. These vessels are built with spar decks, and have commodious and handsome passenger accommodation, in addition to large hold capacity. They will be propelled by twin-screws to suit the limited draft required in inland river navigation, and will be fitted with inverted cylinder geared condensing engines of 90-horse power nominal, by James Aitken and Co., Cranstonhill.

Launch of the "Berlin" at Greenock.

Messrs. Caird and Co. launched, on the 1st ult., from their yard a fine screw steamer of the following dimensions:—Length of keel and forerake, 285 feet; breadth of beam, 39 feet; depth of hold to main deck, 23 feet; to spar deck, 30 feet; tonnage, 2,128 B.M. The vessel, which is intended for the Bremen and Baltimore service, was named *Berlin*, and is now being fitted with engines of 300 nominal horse-power.

Launch of the "Tigre" at Port Glasgow.

Messrs. Robert Duncan and Co. have launched from their yard a fine twin-screw steamer, named the *Tigre*, of the following dimensions:—Length, 180 feet; breadth, 25 feet 6 inches; depth, 9 feet 6 inches; gross tonnage, 330 register, and 570 B.M. The *Tigre* is, we understand, intended for the passenger traffic on the Paraguay river, Monte Video. After the launch she was towed down to Greenock to have her engines put on board by Messrs. Rankin and Blackmore, of the Eagle Foundry.

Launch of the "Lochryan" at Rothsay.

Mr. M'Lay launched, on the 28th of September, a beautiful schooner-rigged vessel, named *Lochryan*, of about 65 tons register. She is owned by Mr. M'Caig, banker, Stranraer, and is intended for the coasting trade.

Recent Shipbuilding Contracts.

Amongst shipbuilding contracts taken at the end of September we find it mentioned that Messrs. Robert Steele and Co., Greenock, have entered into a contract to build two iron ships of 800 tons each, for Messrs. James Richardson and Co., Glasgow; Messrs. Robertson and Co., Greenock, a new iron tug steamer for the Glasgow and Greenock Shipping Company. We also understand that J. H. Carmichael, Esq., Greenock, has just contracted with Messrs. Barclay and Curle, Glasgow, for an iron ship of 1,200 tons.

Shipbuilding on the River Cart.

We understand that an impetus is about to be given to shipbuilding on the Cart by the opening of an extensive iron boatbuilding establishment on the side of the river Cart, near Nethercommon, Paisley. It is said that the new yard will extend to about four imperial acres, and that a large number of hands will be employed. Carpenters' workshops and sheds are in course of erection on the ground. It may here be mentioned that some few years since, during the time that Messrs. Blackwood and Gordon's establishment was on the Cart, some of the smartest river steamers on the Clyde were built on the banks of the Paisley river.

New Steam Ships for the Peninsular and Oriental Company.

The *Bangalore* and *Sumatra*, recently built for the Peninsular and Oriental Company by Messrs. William Denny and Brothers, have proved the fastest ships of the magnificent fleet to which they belong. The *Bangalore*, on her last trip home from Gibraltar, made an exceedingly good run, and intelligence was received here recently of her arrival out again at Gibraltar from Southampton in three days nineteen hours and forty minutes, being an average speed on the run of 12½ knots an hour, and the fastest run on record. The *Sumatra*, which at her trial trip last week attained on four runs an average speed of 14 knots an hour, made the run from the Clyde to Southampton in forty-two hours, being nearly nine hours less than was taken by the *Bangalore*, so that the future performances of this latter ship will be looked forward to with interest.

The Collision in Belfast Lough.

A short time since the divers succeeded in recovering the mail bags which were on board the *Wolf*. The letters and papers were delivered in Glasgow, wet, of course, but on the whole, little the worse for their submersion. Portions of the cargo have also been recovered, and it is confidently expected that the great bulk of the goods on board will be brought up. It appears that the steamer lies in the fairway up the lough, with her head to the North. The bottom is very level, consisting of mud, sand, and shingle, and the vessel sits quite upright. The place is liable in certain winds to a considerable surface swell, but, as the steamer is in such deep water, practical men do not think she can take any additional damage if she were to lie as at present during the winter. In the attempt to raise her the appliances used by Messrs. Harland and Wolfe at the wreck of the *Earl of Dublin* will probably be brought into requisition.

Total Number of Vessels Launched on the Clyde during the Month of September.

The total number of vessels launched on the Clyde during September was fourteen, the total tonnage being 8,366 tons. Of the fourteen vessels launched seven were steamers, all of iron, four being screws and three paddle steamers. Of the seven sailing vessels, four were iron built, two wood, and one (by Mr. Lawrie, Whiteinch) composite.

SHIPBUILDING AND MARINE ENGINEERING IN IRELAND.

Foremost amongst the shipbuilding and engineering firms in Ireland stands that of Messrs. Harland and Wolff, Queens Island, Belfast, who have built fifteen vessels for one English firm, that of the Messrs. Bibby and Co., of Liverpool, whom it is generally admitted possess one of the finest fleets of steamships of any mercantile firm in the world: the latest addition to their fleet was launched by Messrs. Harland and Wolf, on the 31st August last, the vessel was named the *Illyrian*, and is a sister ship to the *Iberian*, launched from the same yard on the 4th of June, and the *Istrian*, launched on the 10th of March. These three magnificent steamships take rank amongst the largest class of vessels, being each 401ft. in length, 37ft. breadth of beam; register tonnage 2,877 tons gross, and upwards of 4,000 tons burthen. The *Illyrian* takes the 20 years' class on the Liverpool registry. The engines and machinery have been supplied by Messrs. Jas. Jack and Co., of Liverpool.

The Raising of the "Wolf."

Messrs. Harland and Wolf, shipbuilders and engineers, Belfast, are to furnish the appliances for raising the *Wolf*. Although there is no special novelty in these, it is worthy of notice that they will consist of the same wrought-iron tanks, etc., as were successfully employed by this firm for floating the *Earl of Dublin*.

REVIEWS AND NOTICES OF NEW BOOKS.

The Essential Elements of Practical Mechanics, based on the Principle of Work, designed for Engineering Students. By Oliver Byrne.

This book is intended to assist that class of persons who have neither the time nor the education to work out mathematical problems for themselves, also to bring out the various results in "units of work," and which, in order to distinguish them from ordinary numbers, are printed in block figures. Many of the various problems in mechanics are worked out simply and well, but the author is unfortunately the inventor of a system which he calls "dual arithmetic," and which, especially in the latter part of the work, is brought into competition with, and substituted for, common arithmetic, until the object of the work is entirely destroyed. We notice, also, some inaccuracies in the book, as, for instance, the method of calculating the slip of the screws (page 314), which, in the example quoted, viz.—speed of vessel, 18 knots; revolutions of screw, 60 per minute; pitch, 30ft.—he makes out to be 12 per cent.

A Treatise on the Strength of Materials. By Peter Barlow, F.R.S., revised by his Sons, P. W. Barlow, F.R.S., and W. H. Barlow, F.R.S., and edited by Wm. Humber, Assoc. Inst. C.E.

The sixth edition of this well-known work has undergone considerable improvement, and has been brought down to the present date by the addition of a summary of various experiments, by Hodgkinson, Fairbairn, and Kirkaldy. When the first edition of this work was published, fifty years ago, comparatively little was known regarding the strength of iron, but, by the additions above mentioned, that deficiency has, in a great measure, been supplied. A few things which would now be considered out of date have been omitted, and, although there is still something rather old-fashioned looking about some parts of the work, it must be acknowledged that it is one of the first books of reference in existence.

Practical Hydraulics. By Thomas Box. London: E. and F. N. Spon.

This work consists of a series of rules and tables for calculating the flow of water through pipes, and also in open cuttings or rivers. It is very complete and carefully arranged, and gives unusual facility for the solution of questions which occur in the daily practice of engineers.

Long-span Railway Bridges. By H. Baker. London: E. and F. N. Spon.

In this work the author has investigated the various merits of different well-known systems applied in the construction of girders, more especially when required for bridges of long span, by which term he means anything over 300ft. The investigations are simple and practical; the diagram of gross weight per foot run of the various systems illustrating at a glance the result of his calculations. The book is very carefully got up, and the plates are especially clear and distinct.

The Designing and Construction of Storage Reservoirs. By Arthur Jacobs. London: E. and F. N. Spon.

This is a reprint of a paper read before the Society of Engineers, when it was awarded the Society's premium. It has internal evidence of great care being betowed upon the subject, and the various rules given, combined with some excellent plates, illustrating many of the large works of this description at present in existence, will be found very useful.

NOTICES TO CORRESPONDENTS.

In the recent session of Parliament the directors of the Great Western Railway were limited in their number to sixteen. They are Sir Daniel Gooch, Bart., M.P., London, Chairman; Mr. Charles Alexander Wood, London, Deputy-Chairman; Mr. Richard Bassett, Cardiff; Mr. Francis L. Dillwyn, M.P., Swansea; Mr. William C. King, Bracknell, Berks; Mr. Edward Leeming, Richmond; Mr. Richard Michell, London; Mr. John W. Miles, Bristol; the Hon. Frederick G. B. Ponsonby, London; Mr. Christopher R. M. Talbot, M.P., Margam Park, South Wales; Mr. Rowland J. Venables, Oswestry; Mr. Edward Wanklyn, Slough; Sir W. W. Wynn, Bart., M.P., Wynnstay; and Mr. Edward Smith, Sheffield. These are evidently names of reputable men; but we do not pretend to know who does the work, which can be done well only by constant, diligent attention and a clear understanding.

LATEST PRICES IN THE LONDON METAL MARKET.

	From £	s.	d.	To £	s.	d.
COPPER.						
Best selected, per ton	79	0	0	80	0	0
Tough cake and tile do.	77	0	0	78	0	0
Sheathing and sheets do.	80	0	0	81	0	0
Bolts do.	83	0	0	,,	,,	,,
Bottoms do.	85	0	0	,,	,,	,,
Old (exchange) do.	70	0	0	71	0	0
Burra Burra do.	84	0	0	85	0	0
Wire, per lb.	0	1	0	,,	1	0½
Tubes do.	0	0	11½	0	1	0
BRASS.						
Sheets, per lb.	0	0	9	0	0	10
Wire do.	0	0	8½	0	0	9½
Tubes do.	0	0	10½	,,	,,	11
Yellow metal sheath do.	0	0	7¼	0	0	,,
Sheets do.	0	0	7	,,	,,	,,
SPELTER.						
Foreign on the spot, per ton	21	2	6	,,	,,	,,
Do. to arrive	21	12	6	,,	,,	,,
ZINC.						
In sheets, per ton	28	0	0	,,	,,	,,
TIN.						
English blocks, per ton	96	0	0	,,	,,	,,
Do. bars (in barrels) do.	97	0	0	,,	,,	,,
Do. refined do.	99	0	0	,,	,,	,,
Banca do.	92	0	0	93	0	0
Straits do.	90	0	0	91	10	0
TIN PLATES.*						
IC. charcoal, 1st quality, per box	1	7	6	1	9	6
IX. do. 1st quality do.	1	13	6	1	15	6
IC. do. 2nd quality do.	1	5	6	1	7	6
IX. do. 2nd quality do.	1	11	6	1	13	6
IC. Coke do.	1	3	6	1	4	6
IX. do. do	1	9	6	1	10	6
Canada plates, per ton	13	10	0	,,	,,	,,
Do. at works do.	12	10	0	,,	,,	,,
IRON.						
Bars, Welsh, in London, per ton	6	10	0	,,	,,	,,
Do. to arrive do.	6	10	0	,,	,,	,,
Nail rods do.	7	0	0	7	10	0
Stafford in London do.	7	10	0	8	10	0
Bars do. do.	7	10	0	9	10	0
Hoops do. do.	8	10	0	9	12	6
Sheets, single, do.	9	5	0	10	0	0
Pig No. 1 in Wales do.	3	15	0	4	5	0
Refined metal do.	4	0	0	5	0	0
Bars, common, do.	5	15	0	6	0	0
Do. mrch. Tyne or Tees do.	6	10	0	,,	,,	,,
Do. railway, in Wales, do.	5	10	0	6	0	0
Do. Swedish in London do.	10	2	6	10	5	0
To arrive do.	10	5	0	,,	,,	,,
Pig No. 1 in Clyde do.	2	15	9	3	1	6
Do. f.o.b. Tyne or Tees do.	2	9	6	,,	,,	,,
Do. No. 3 and 4 f.o.b. do.	2	6	6	2	7	0
Railway chairs do.	5	10	0	5	15	0
Do. spikes do.	11	0	0	12	0	0
Indian charcoal pig in London do.	7	0	0	7	10	0
STEEL.						
Swedish in kegs (rolled), per ton	14	5	0	,,	,,	,,
Do. (hammered) do.	15	10	0	15	15	0
Do. in faggots do.	16	0	0	,,	,,	,,
English spring do.	17	0	0	23	0	0
Quicksilver, per bottle	6	17	0	,,	,,	,,
LEAD.						
English pig, common, per ton	19	12	6	,,	,,	,,
Ditto. L.B. do.	20	0	0	,,	,,	,,
Do. W.B. do.	21	15	0	,,	,,	,,
Do., ordinary soft, do.†	20	0	0	,,	,,	,,
Do. sheet, do.	20	10	0	20	15	0
Do. red lead do.	20	15	0	21	5	0
Do. white do.	27	0	0	30	0	0
Do. patent shot do.	23	0	0	,,	,,	,,
Spanish do.	19	10	0	,,	,,	,,

* At the works 1s. to 1s. 6d. per box less.
† A Derbyshire quotation, not generally known in the London market.

NOTES AND NOVELTIES.

MISCELLANEOUS.

Death of the Inventor of the Sewing Machine.—An American paper announces the death of Elias Howe, jun., the inventor of the sewing machine, on the 3rd ult., in the midst of his family and friends at Bridgeport, Connecticut. Elias Howe was born 1819, at Spencer, in Massachusetts. It was at Boston, in the shop of Ari Davis, where he first thought of the sewing machine. Poverty for some time prevented the development of his ideas, but in 1844 he succeeded in convincing a friend with some means of the feasibility of his conception. In April, 1845, he sewed a seam with his machine, and by May of the same year he had completed his work.

Steam Generation and Smoke Prevention.—A series of experiments to decide these important questions have been going on during the past eighteen months, under the direction of the late Dr. Richardson, of Newcastle, and Mr. L. E. Fletcher, chief engineer to the Association for preventing Steam Boiler Explosions. These experiments are conducted on a large scale, and the expenses have been borne by the South Lancashire and Cheshire Coal Association. Although the experiments are not yet completed, being still in daily progress, they demonstrate the correctness of the position which we have often been called on to take, in relation to these very questions, namely, that the formation of smoke may be entirely prevented, without any diminution of the evaporative efficiency of the coal, *by careful firing* alone, whilst economy is promoted at same time.

An insufficiently-balanced travelling crane, erected at Pembroke Dockyard for raising the heavy iron armour-plates round the stern of H.M.S. *Penelope*, toppled over and fell about 40ft. into the dock. Unfortunately, three men were killed and two were severely injured.

An "eccentric pump" is said to be invented by Messrs. Wilson and Hall, who are workmen in the employ of Messrs. Hawthorn, of Newcastle. The bore was 3½in., and raised —by hand—40 gallons per minute. When worked by a steam-engine, and with a 3¾in. pipe attached, it raised 47 gallons in 27 seconds, and projected the fluid to an altitude of 64 feet. We shall certainly hear more of such a pump, as it operates in "the absence of valves," if there be "no mistake" about it.

We near that the Dowlais Iron Company has purchased for £10,000 the exclusive right of working Bessemer's patent in Glamorganshire.

Education.—We learn from the report of Mr. Baker, who is a factory inspector, that there are upwards of 3,000 working children at school in the Potteries, with a marked effect on their habits and deportment. These have all been put to school since 1st January, 1865, and there is no complaint of their being now compelled to attend school, as Mr. B. adds, a "proof of the compatibility of labour with education."

During the civil war in America an ingenious and economical method was adopted for getting water for the troops. It has recently been repeated with similar success. It consists of a 1¼in. iron pipe about 12ft. long, and brought to a point at one end. The pointed which is also the lower end, is perforated with holes to about 16in. up from the point. A moveable iron clamp is fitted to the pipe, and a 56lb. pound weight is raised and allowed to fall on the clamp, to drive the pipe into the ground. The earth, sand, &c., that enters the pipe by the holes are easily removed by the pump when the point enters water. The coarser sand or pebbles now surround the perforations, and filter the water before entering the pipe to be pumped up. The surface drainage may thus be shut off, and the water comes up cool and fresh. The cost of sinking such a well, 15ft. deep, need not exceed £5.

A New Ships' Compass by the Earl of Caithness.—A compass on a new principle has been recently patented by the Earl of Caithness. The details of the invention are distinguished by their simplicity, and are such as will be calculated to be of the greatest importance to seafaring men. The compass was tested on board the new Cunard steamer the *Russia* upon the occasion of her recent trial, and the result was in the highest degree to show its great superiority to that now in use. In addition to its chief recommendation of simplicity, it possesses other important features deserving of notice, such as its not being affected by those influences that produce motion in other compasses, the absence of the pendulum, &c. We understand one of our eminent makers of compasses is about going into the manufacture, on a large scale, of this new compass.

London to Cherbourg.—A line of steam vessels that has been now for some time established between Poole, on the south coast of England, and Cherbourg, on the north coast of France, have, by a fresh arrangement on the part of the company to which they belong, now made Southsea, Portsmouth, as their last point of departure from the English coast for the great French port, and the first port of call on their return to the English coast. Cherbourg is thus brought within eleven hours' passenger communication with London, and at an extraordinarily low rate of fares. The voyage to and from the coasts of the two kingdoms by this route is at the present season made weekly; and, although the boats as yet have only made three passages each way, a fair number of passengers have been carried, and considerable freights of sheep, pigs, poultry, eggs, butter, &c., brought over from the Normandy dairy farms.

Critical State of the Dykes in Holland.—Alarming rumours are in circulation in Antwerp. It is asserted that the weirage of the eastern branch of the Scheldt, in altering the course of the river, has acted in a disastrous manner on the dykes. They are menaced on several points and they must all be straightened—an immense labour, which will cost millions, and perhaps cannot be finished in time to prevent a disaster. If this is true the unforeseen result of the works on the Scheldt would show that the Dutch engineers were right.

The low stage of water on the Ohio river is making coal a scarce article in Cincinnati, Louisville, and other cities. It is stated that several of the largest manufacturing establishments in New Albany, Indiana, will have to suspend operations within the next three or four weeks, unless they are able to replenish their stocks of coal.

From the North.—Messrs. Wigham, Richardson, and Co. have completed a large order for iron buoys, for the London Trinity House, and they are completing a powerful tug for the Commissioners of Northern Lights. Messrs. C. Mitchell and Co, have completed a steamer of 1,000 tons, named the *Capella*, which will trade with passengers and goods between London and Hamburg. Messrs. Hepple have contracted with the River Tyne Commissioners to build a new floating ferry for Shields.

TELEGRAPHIC ENGINEERING.

The Prussian Government proposes to teach the army the management of the telegraph.

The Atlantic Telegraph Tariff.—The chairman, at a recent meeting, said "it was now proposed to allow a message of ten words for £5 5s., giving in five for name and address, and if the alterations were successful it would only pave the way to still further reductions in the interest of the public."

RAILWAYS.

The decision of the Government to land the West India mails at Plymouth, must reduce the risks of the Channel, which are many and great, and improve the resources of the Great Western, Bristol and Exeter, and the South Devon Railway.

ACCIDENTS.

An accident recently deprived a boiler-maker of life. He had repaired a boiler, and had got up steam to test his work, when a leak was seen to issue from a cement joint of the steam pipe. He attempted—what no engineer would have attempted on a cement joint with the steam up—to caulk it, which loosened the cement, and the steam blew it into his face with a force that drove him several yards. He was much scalded, and taken up a corpse. His name was John Blackburn, aged 46 years, and had worked at Maudslay's, Lambeth.

DOCKS, HARBOURS, BRIDGES.

The Projected Harbour Improvements at Aberdeen.—The Aberdeen Harbour Commissioners have recently decided that the professional advice of Mr. Hawkshaw, C.E., and Mr. Abernethy, C.E., should be obtained before finally approving of the new works suggested by their own engineer, Mr. W. Dyce Cay, C.E., and of which mention was made in a former number. These gentlemen have agreed to visit the "Granite City" on an early day.

Adoption of Messrs. Bell and Miller's Report on the River Ribble.—The report prepared by Messrs. Bell and Miller, the eminent civil engineers in this city, has been adopted by the Corporation of Preston. It is proposed to expend a sum of £50,000 on improvements of the River Ribble, so as to render it navigable for vessels of large size, and in the construction of wet docks.

It appears that the harbour of Dundee is filling up fast. The Commissioners have furnished dredgers, and only want the punts necessary for receiving and removing the silt when dredged It must be false economy to do such things by halves. At Aberdeen, no less than 19,456 tons have been dredged from the bar there during the past mouth, and disposed of in the usual manner.

Some interesting statistics were educed from the experience of the trustees of the Clyde navigation, at their meeting in Glasgow on the 3rd ult. The quantity of material dredged this year amounts to 702,308 cubic yards, and the cost of dredging and depositing is 9·176d. per yard. In the previous year it was 8·188d., and the quantity 560,176 cubic yards. The dredging this year is 75·4 cubic yards, per hour's work, against 71·1 yards in 1865, and 47 yards in 1864. The revenues of the trust have increased from £37,643 in 1837, to £131,892 in 1865. The revenue of the month of August last is £1,362 in excess of the corresponding month of last year. A committee was appointed to take the necessary steps for providing a graving dock. The trustees possess the necessary ground and the estimated expense is £60,000.

The date now fixed for opening the Suez Canal is October, 1869. The expenditure on the works during the past year amounts to £2,520,000, in round numbers.

MINES, METALLURGY, &c.

The Polyphant Stone.—There is a stone raised under this name in Cornwall, which can be cut by a handsaw with ease, when first raised, and hardens in time. It occurs of a neutral grey colour, and also of a green with red spots. It is admired by architects for its chromatic effects.

Tin Plates.—Thin as "a sheet of tin" may be, we all know that it is three thicknesses of metal. The body is of iron, of good quality, or the "tin" will break, when it should only bend. To clean the sheet of iron so that the melted tin can adhere to its surfaces, it is dipped in acids, passed through a furnace, and the oxide cleansed off by manual labour. We need not linger on details now, but proceed to notice an asserted improvement claimed for Mr. T. F. Parsons, of Maindee. The plates are passed between cast-iron rolls to produce a bright face and remove all blemishes. The acids, the furnace, and the manual labour for cleansing are thus superseded, whilst the economy must be as evident as the fact. But we do not vouch for the fact in the absence of experience, which can be quickly obtained in any tin-work. Therefore we invite further information on this subject.

A Letter from Carson City, Nevada, dated 28th ult., says:—"All over the state discoveries are being made of rich silver-bearing lodes, many of which, in the estimation of the proprietors at least, rival the 'Comstock,' and we wait now only the construction of the great overland railroad through the state to cheapen transportation, and thus reduce the expense of developing our mines, to enjoy the prosperity which we have had so long in prospect."

Rock crystal, of very fine quality, has been discovered in Arkansas. Rock crystal is described as the purest vitreous variety of quartz, and includes pure regularly-formed crystals of quartz, their most usual form being that of hexagonal prisms, surmounted by pyramids. In the United States it was first discovered in Herkimer county, New York, and afterwards in London county, Virginia, and in the State of Vermont and other localities.

The Cleveland Iron Trade.—The make of pig for the quarter ending September 30 showed an increase upon the previous quarter of 10,133 tons, while there was a decrease in makers' stocks, notwithstanding the increase in the make, of 7,242 tons. The demand for pig iron for Belgium and France, as compared with the shipments in the early part of the year, continues limited. In foundry work there is not much fresh business reported, although the various works are tolerably busy. The demand for rails continues steady, and it is said that a further large order for Holland has been placed in the district. The mills and forges are busy on this description of work, and heavy shipments will be made to Riga and Cronstadt until the navigations close. A large quantity of railway *materiel* is also being forwarded to Egypt.

GAS SUPPLY.

Metropolitan Gas Companies.—There is a proposal on foot for amalgamating the thirteen London gas companies into four, and thus assigning them districts. It appears to be favourably reviewed by the companies that one district should be assigned to the Chartered, the London, the Equitable, and the Western; and the gas supplied in 1866 by these four companies was 2,650,832,000 cubic feet. Another district would be allotted to the Imperial and the Independent, whose make of gas in 1866 was 2,761,017,000 cubic feet. A third district would comprise the City of London, the Central, Commercial, and the Radcliff, which last year sold 1,690,340,551 cubic feet. A fourth district would be supplied by the Phœnix, the South Metropolitan, and the Surrey, which last year sold 1,551,328,000 cubic feet.

WATER SUPPLY.

The Town Council of Carlisle are determined to proceed with their new filter-beds although their borrowing powers are exhausted, but may be enlarged in the coming session of Parliament. The tender of Messrs. Nelson was accepted.

Oban Waterworks.—It appears from his own report, that Mr. Mackay, the engineer of these works, has been misled in the anticipated productiveness of the water supply. Mr. Mackey suggests two remedies:—First, that the Glencruitten burn water be made use of at a cost of £315. Second, to lay a pipe from the town of Soroba—a source of supply in no way connected with the other—at a cost of £550.

Maine is a state that has, for its size, a large amount of most valuable water privileges. It is estimated, indeed, that there is in Maine, water power enough, if properly employed, to support 5,000,000 of the people. In the southern part of the state the water power amounts to at least 1,000,000 horse power, and nearly every town has at least one and sometimes many mill privileges.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from this office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated September 13th, 1867.

2589 H. Symons—Fire guards and fire screens
2590 P. R. Couchoud—Manufacturing chenille
2591 J. Reid—Finishing parts of locomotive wheels
2592 F. A. Paget—Preventing the deviation of the compasses of ships
2593 W. F. Bathn—Heating, evaporating and cooling liquids
2594 R. Lowe and J. Taylor—Articles of jewellery
2595 J. M. Napier—Wine glasses
2596 S. Dalton—Iron and steel
2597 W. Whitehead—Printing fabrics

Dated September 14th, 1867.

2598 H. A. Bonneville—Railway brake
2599 W. G. Brownsou—Telegraphic apparatus
2600 W. E. Newton—Increasing the efficiency of steam for motive power purposes
2601 J. Antill and H. C. Tuuks—Construction of cores
2602 H. A. Bordin—Preventing sea sickness
2603 R. Canham—Sharpening edged articles
2604 J. Jeyes—Material to be used as a substitute for waterproof materials and leather

Dated September 16th, 1867.

2605 P. Crause—Propelling vessels
2606 G. Pickin — Treatment and preparation of mineral oils and spirits
2607 J. A. McKean—Cotting rocks, &c.
2608 P. Dumont—Manufacture of soap
2609 G. F. Bradbury and G. Chadwick—Sewing machines
2610 W. J. Cunningham—Sewing machines, &c.

Dated September 17th, 1867.

2611 C. Holste—Blast furnaces
2612 W. Le Duc—Mode of covering roofs
2613 W. Brailsford and J. Gadsby—Lace made on bobbin
2614 J. C. Bayley and D. Campbell—Fire lighters and fire revivers
2615 T. Turner—Mounts for maps, &c.
2616 S. Jay—Securing articles of apparel
2617 S. C. Amesbury—Communicating between passengers and guards of railway trains, &c.
2618 T. Bell—Treating the oxide of iron residues of gas purifying
2619 D. Gardner—Spring mattresses, &c.
2620 T. Steveuson—Faggots
2621 A. M. Clark—Valve closet apparatus

Dated September 18th, 1867.

2622 F. H. Varley—Testing telegraph conductors
2623 W. W. Burdon—Bleaching fibre
2624 C. Lister and G. Storey—Looms for weaving
2625 T. Adams and G. J. Parson—Slide valves
2626 J. Soames—Candle fixer
2627 T. B. Wilkinson—Crushing grain or seed
2628 H. M. Mellor—Circular knitting frames

Dated September 19th, 1867.

2629 R. Watson—Distributing gas
2630 T. C. Clarkson—Ammunition boxes, &c.
2631 P. Porter—Improved roller
2632 J. Rust—Material for decorative purposes
2633 W. J. Murphy — Obtaining and applying motive power
2634 J. Huggins—A polarising kaleidoscope
2635 W. Molineaux—Machinery for rolling bars
2636 T. Bletcher—Sewing machines
2637 J. G. Willans—Manufacture of iron
2638 H. Fisher—Improvements in furnaces
2639 J. H. Sams—Drill sowing machines, &c.

Dated September 20th, 1867.

2640 W. W. Gibson—Decorticating and cleaning cereals
2641 W. Potts—Ventilating rooms and buildings
2642 J. J. Harrison and E. Harrison — Carding engines
2643 L. Lenzberg—Gas lamps and burners
2644 A. M. Clark—Tinting artificial flowers and foliage
2645 F. T. M. A. Guyon—Typographic fixiform
2646 C. McDermott—Slate sponge
2647 C. McDermott—Metallic seal for envelopes
2648 J. G. Tongue—Preparation of oils, &c.
2649 R. Raffault—Petticoat
2650 S. Dreyfous—Bread ovens
2651 E. A. Newby—Alarm apparatus
2652 W. Hall—Separating yeast from liquid matters
2653 W. E. Newton—Whips and whip holders

Dated September 21st, 1867.

2654 C. E. Green and J. Green — Cartridges for breech-loading firearms
2655 P. Crause—Ventilators for coverings for the head
2656 G. E. Marchisio—Treatment and application of the residuum which results from the clarification and purification of vegetable drying oils, &c.
2657 J. Hargreaves—Manufacture of iron
2658 D. Howard—Union fabrics
2659 J. S. Williamson — Drying, cleaning, and separating grain
2660 A. L. Dickins and H. Heywood - Printing yarns or threads
2661 D. T. Lee—Combination of animal with vegetable food
2662 B. Blackburn and A. B. Blackburn- Lucifer matches, &c.
2663 J. Meiklejon—Lifting, lowering and transporting heavy bodies
2664 J. Baird—Treatment of jute, &c.
2665 A. Mackensie and S. Robinson—Preventing waste of water
2666 D. Spill—Treatment of xyloidine
2667 T Muir—Washing rollers and blankets used by printers, &c.
2668 A. Aitchison and H. J. Grautham—Production of carburetted gas
2669 J. Rives—Metallic pens
2670 S. C. Lister—Furnaces
2671 T. Kendrick—Self-acting folding carriage steps
2672 J. R Cooper—Firearms

Dated September 23rd, 1867.

2673 G. W. MacGeorge—Pipes for smoking
2674 C Ritchie — Regulating automatically the supply of gas, etc.
2675 J. Griffin and F Green—Envelopes
2676 J. Fletcher—Power hammers
2677 W. Cooke—Regulation of up and down currents of air
2678 J. Hargreaves—Separating impurities from coal
2679 W. Beardmore, W. Brock, and A. C. Kirk—Furnaces
2680 J. Blair—Revivifying animal charcoal
2681 R. Wappenstein and A. Laidlaw—Envelopes
2682 L R. Bodmer—Air cylinders of blast engines
2683 A. M. Clark—Boots and shoes
2684 S. Bevan—Ventilating underground railways and other like structures
2685 A. Ziegele—Epsom salts

Dated September 24th, 1867.

2686 H. Forbes—Rotary pumps
2687 W. Winter—Sewing machines
2688 G. Batcheldor—Trough water closets
2689 J. Lewis, W. Huntington, and W. Anyon—Movable fire bars
2690 J. H. Brown—Paper and articles of paper
2691 P. H. Colomb and F. J. Bolton—Production of light and heat
2692 T. H. Williams—Gas burners

Dated September 25th, 1867.

2693 R. Wilson and J. Nuttall—Heavy forgings
2694 C D. Abel—Converting the gaseous products of combustion into combustible gases
2695 J. C. Bayley and D. Campbell—Projectiles and their manufacture
2696 D. R. Ratcliff—Safes and other depositories
2697 W. Mc. Cranston — Implements for digging potatoes
2698 J. Musgrave—Fittings for cow houses, &c.
2699 A. Toil and J. Heatley—Tobacco
2700 G. Clayton and W. Marbeck—Water meters
2701 W. Woodcock — Warming and ventilating buildings
2702 R. Waygood—Cleaning seed
2703 A. Rooker—Taps for vessels
2704 J. Bower—Iron and steel
2705 A. M. Clark—Combined tuck creaser and self-guide
2706 J. Kirk and J. Kirk—Production of lace made on twist lace machines

Dated September 26th, 1867.

2707 J. Oxley—Refrigerators for cooling worts and other liquids
2708 G. H J. Simmons—Lamps for burning oils
2709 J. A. Smyth—Cinder sifters
2710 A. Taylor—Weaving ornamental fabrics
2711 R. W. Bennie—Moulders' blackening
2712 J. Syme—Supporting window sashes, &c.
2713 J. Wood, B. Wood, and R. Wood—Steam engines
2714 A. Morrall—Fish hooks
2715 J. Jameson—Preparation of paper
2716 G. Wilkinson—Pumps
2717 E. T. Horsley and C. Horsley—Production of a glazed surface on cast metal
2718 J. Brunton—Raising water
2719 J. Jameson—Improvements in the indication of documents
5720 A. V. Newton—Turning and screw cutting
2721 J. Fordred—Bleaching and purifying paraffin
2722 J. H. Johnson—Supplying steam boilers with water
2723 T. Vaughton and O. Vaughton—Necktie ribbon

Dated September 27th, 1867.

2724 J. E. H. Andrew—Looms for weaving
2725 R Adams—Extracting cartridge cases from breech loading firearms
2726 M. Samuelson—Sewing machines
2727 F. Frew and J. Speirs—Looms for weaving
2728 A. M. Clark—Hat blocking machine
2729 S. Parr and A. Strong—Construction of buildings, &c.
2730 J. Cocker and F. S. Cocker—Transmitting signals in railway trains
2731 L. de la Peyrouse—Treatment of paraffine, fatty and resinous matters
2732 F. Branscombe—Drilling, &c.
2733 J. Huggett and J. A. Hoggett—Nails, &c.
2734 F. Meyer and W. Wainwright—Candles and moulds for the same

Dated September 28th, 1867.

2735 C. Mole—Soles and heels for boots and shoes
2736 H. A. Bonneville—Treating skins
2737 L. Laine—Improved fan
2738 A. Ward and C. G. Virg — Adaptation of materials specially prepared for the manufacture of certain articles of wearing apparel
2739 J. H. Johnson—Railway wheels
2740 G. R. Solomon—Registering passengers travelling in public vehicles
2741 E. Lever—Improvements in lamps
2742 H. Killogg—Hats, and machines for producing the same
2743 J. Elder—Propelling and manœuvring floating batteries &c.
2744 M. Hamer—Manufacturing india rubber tubing
3745 T. Prideaux—Blast furnace or cupolas
2746 T. Silver—Lubricating packing

Dated September 30th, 1867.

2747 B. Dobson and R. Halliwell—Mules for spinning and doubling
2748 C. P Jones—Removing adhering matters from the bottoms and sides of navigable vessels while at sea
2749 T. Weston—Ornamental metallic tubes
2750 J. Dimock—Boiling eggs, &c.
2751 W. James and W. Hill—Attaching and securing watch chains, &c.
2752 J. Donald—Burning oil in furnaces
2753 J. Dewar—Preserving potatoes
2754 C. Honegger—Loom for weaving figured fabrics
2755 J. Clark—Locomotive engines and their permanent ways

Dated October 31st, 1867.

2756 E. P. Alexander—Cast steel, &c.
2757 T. Bird—Furnaces, &c.
2758 H. A. Bonneville—Spinning fibrous materials
2759 J. G. Jones—Winding ropes
2760 G. Allibon and A. Maubré — Conversion of cereal and vegetable substances into saccharine matter, &c.
2761 J. L Field—Candles, and moulds
2762 G. F. Green—Combined billiard and dining table
2763 W. Mitchell—Sharpening the knives in mowing and reaping machines
2764 W. E. Gedge—Match boxes
2765 R. Fletcher—Improved castor
2766 T. E. Clark —Construction of bedsteads and mattresses

Dated October 2nd, 1867.

2767 W. Smith and S. Smith—Construction and working of back rollers, &c.
2768 R. H. Taunton—Sheet iron for certain purposes
2769 F. Parkes—Certain descriptions of nails
2770 A. C. Henderson—Sewing machines
2771 C J. Appleby—Railway fastenings
2772 C. Ritchie — Mechanism applicable to steam boilers and their furnaces
2773 J. H. Nelson and T. Briggs—Heating the feed water of steam boilers, &c.
2774 M. Wright—Species of fabrics
2775 G. Ramsden, L. Webster, and J. Walker—Fulling machines
2776 F. J. Jeffery—Urinals
2777 C. Mace—Marine steam boilers
2778 H. Haschke—Breech loading firearms
2779 W. R Lake—Sewing boots and shoes

Dated October 3rd, 1867.

2780 W Spence—Ovens, boilers, &c.
2781 R. Dick—Heating furnaces, &c.
2782 H. D. Pochin and E. Hunt—Furnaces, &c.
2783 G. P Dodge—India rubber mats
2784 W. E. Gedge—Portable laboratory
2785 A. M. Clark—Treatment of fibrous materials used in dentistry
2786 E. B. de Richebourg - Mode of advertising
2787 G. Townsend—Machine needles
2788 G. Mellor—Nails and spikes
2789 A. T. Becks—Utilisation of Bessemer steel scrap

Dated October 4th, 1867.

2790 T. Sagar and T Richmond—Looms for weaving
2791 S Johnson—Moulding, perforating, and pressing bricks, &c.
2792 H. Pinkus—Steam generators for engines, &c.
2793 A. Ford—Assisting swimming
2794 J. Gutmann—Sewing machines
2795 W. Smith—Switch indicators used on railways
2796 J. Offord—Carriages and various parts of the same
2797 R. Ellis — Disconnecting conveyances from animals drawing the same
2798 G. H. D. Matbias—Construction of ships and vessels
2799 J. H Johnson—Manufacture of bread
2800 R. Hattersley—Distributing printers' type

Dated October 5th, 1867.

2801 J. Anderson—Obtaining chlorine, etc.
2802 W. E. Gedge—Formation of wrapper
2803 G. Martin—Treatment of mixed fabrics
2804 J. S. Williamson—Drying corn, etc.
2805 W. Low and J. Treadwell—Riveting the soles of boots and shoes
2806 A. M. Gillham—Steam engine
2807 A. Bradburn and S. T. Marsh—Jointed rules
2808 W. R. Lake—Making bolts
2809 L. Williams—Combined lift and force pump
2810 J. Piddington—Pneumatic springs
2811 N. F. Taylor—Means to be used in impregnating air and aeriform gases with hydrocarbons

Dated October 7th, 1867.

2812 J. Goodfellow—Steam engines
2813 J. Smith—Moulding metal
2814 H. Fauider—Washing and cleaning fruit
2815 C. J. Galloway—Looms for weaving
2816 C. D. Abel—Refining camphor
2817 R. P. Fauchenx—Pipes and cigar tubes
2818 J. A. Mays—Lamps, etc.
2819 D. Swan—Manufacture of zinc
2820 H. Trotter—Manufacture and packing of fire lighters
2821 T. Ollis—Registering apparatus
2822 J. H. Brown—Utilising refuse animal matters and producing skins and sheets therefrom

Dated October 8th, 1867.

2823 R. Garratt—Ball and other cocks
2824 E. Bromgfield—Lifting machine
2825 J. Dean and T. Turton—Prevention or consumption of smoke
2826 J. B. Hulme—Apparatus to be used in excavating
2827 J. Reading, S. A. Reading, G. E. Reading, and F. Reading—Uniting busks
2828 A. Ticozzi- Lotion for diseases of the eyes
2829 R Beard—Stoppers for vessels
2830 F. Lane, W. Armstrong, and L. Widdowson—Boring holes in minerals
2831 J. B. Brown—Improvements in lamps
2832 J. Player—Manufacture and rebuing of iron and steel
2833 E. G. Wolffgan—Ribbons
2834 R. Reid and E. H. Craigie—Mattresses, etc.

Dated August 9th, 1867.

2835 A. Danilecki—Medical electric bath
2836 J. Barker—Consuming smoke
2837 J. H. Johnson—Projectiles
2838 H Wallwork—Hats
2839 J James and T. Jones—Articles of iron
2840 W. Potts—Gaseliers
2841 J. Speight—Spinning, twisting, and roving fibrous substances
2842 R. Smith—Mounting and driving millstones
2843 E. G. P Thomas—Dyeing black and grey, etc.
2844 T. Nelson—Preparing the surfaces of material for drawing purposes
2845 W. Warren—Arrangement and construction o street sweeping and cleaning machines

Dated October 10th, 1867.

2846 C. Avery—Increasing the celerity and safety o loading guns and pistols at the breech, and of discharging the same
2847 R. Brotherton and J. Maldrou—Lamp posts
2848 T. Blackhurst—Improved composition
2849 A. F. Hobhouse—Propelling vessels
2850 W. R Lake—Bunging barrels or casks
2851 G. Twigg—Corkscrews

Dated October 11th, 1867.

2852 A M. Clark—Treatment of extracts of madder
2853 R George—Warming and ventilating apartments and buildings
2854 J. Withinshaw and J. E. Baker—Steam pumps and blowing engines
2855 E. Haigh—Planking the bodies of hats
2856 J. C. Wilson—Rice unhusking mill
2857 J. C. Wilson—Steam boilers
2858 G. Davies—Manufacture of corsets
2859 J. Brunner—Construction of gas burners
2860 W. H. May and Peter Graham—Stoppers for vessels
2861 A. Helwig—Feeding apparatus for maintaining a proper water level in vessels
2862 R. A. Wright—Method of and apparatus for heating
2863 E. Leitenberger—Separating soluble from insoluble matters, etc.
2864 G Angell—Portable fountains
2865 W. E. Newton—Preparing iron
2866 W. Butler—Rolling of strip iron for hoops

Dated October 12th, 1867.

2867 H. B. Barlow—Sewing machines
2868 J Buckingham and J. S. Blockey—Regulating the feed of steam boilers
2869 C. H. Collette—Construction of flights of stairs
2870 R. F. Baie and J. Thomson—Transmission of fluids
2871 J. B. P. A. Tbierry—Smoke consuming apparatus
2872 H. A. Dofrene—Decorticating grain
2873 R. Cunbam and J. Thomson—Stoves for consuming fuel, etc.
2874 E Leitenberg—Treating madder
2875 H. Forman—Wheels of traction engines
2876 J. Drubble—Securing handles and scales to every description of cutlery
3877 J. H. Johnson—Knitting machines
2878 B. Nicoll—Economical construction of buildings, etc.
2879 W. R. Lake—Electric telegraphic apparatus

Dated October 14th, 1867.

2880 J. C. Pearce—Furnaces and fire grates
2881 D. E. Blacke—Spinning and twisting yarns
2882 E. Ward—Coverings for the head
2883 W. Godd and B. Walker — Manufacture of narrow fabrics
2884 M. Fitzpatrick — Prevention of accidents on railways
2885 W. Redgate and T. Marriott—Manufacture of lace in twist lace machines
2886 H. N. Maynard—Bridges, piers, and landing stages
2887 W. R. Lake — Loading heavy ordnance with projectiles
2888 W. R Lake—Revolving batteries, etc.
2889 M. A. M. Mennons — Transmitting alarm signals, and applying brake power in railway trains

Dated October 15th, 1867.

2890 H. A. Bonneville—Superheating vapours
2891 H. A Bonneville—Threading needles
2892 M. Vogl and H. Van Dyk—Articles consisting of muffs combined with bags, etc., and the frames of such receptacles
2893 A. Aitchison—Treatment of hydrocarbons
2894 T H. Baker and T. Woodroffe — Treating liquid matters
2895 M. Samuelson—Sewing machines
2896 W. R. Lake—Construction of railways and railway carriages, etc.
2897 H. A. Leveson—Pack saddles

Dated October 16th, 1867.

2898 B. Latham—Distributing sewage over land
2899 A. M. Clark—Producing motive power
2900 A. Prince and A. C. M. Prince—Telegraphic communication by pneumatic means, and apparatus employed therein.
2901 F. D Frost—Rollers used in frames for preparing fibrous materials
2902 C. Tinet—Construction of seats
2903 E. Gessner—Folling machines
2904 W. E. Newton.—Preparation of wood

FIG. 1 STEPHENSON.

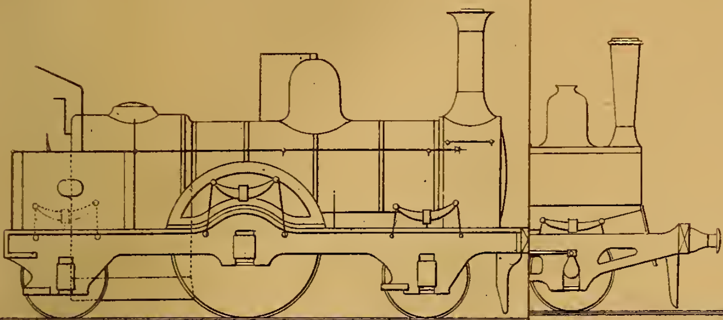


FIG. 4. CREUSOT SINCLAIR

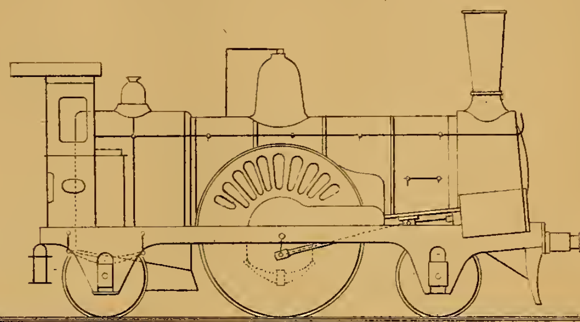


FIG. 5. SIGL.

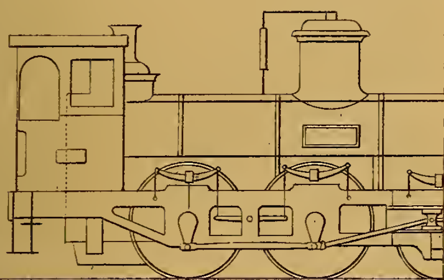


FIG. 7. KITSON

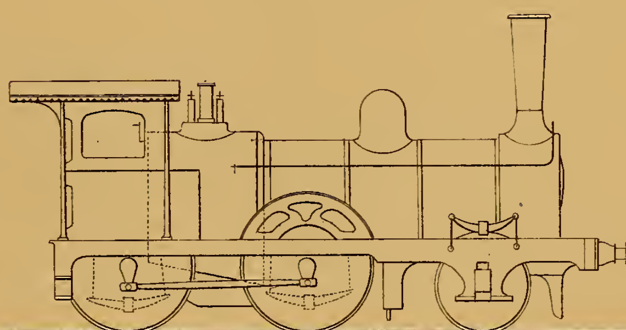


FIG. 8 VORUZ

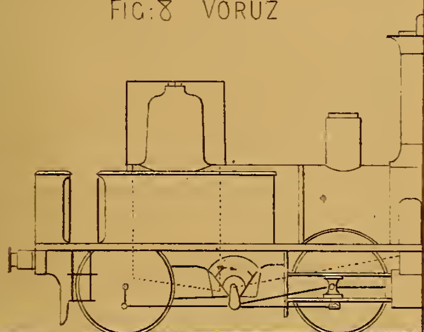


FIG. 11. KRAUSS

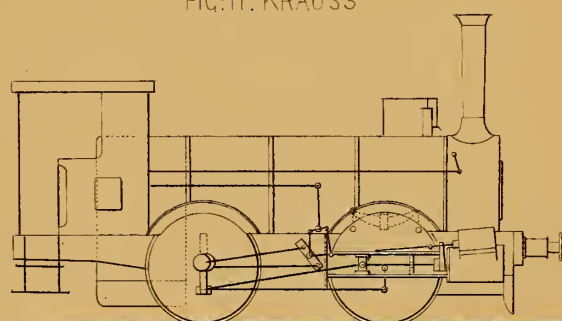


FIG. 12 CARLSRUHE.

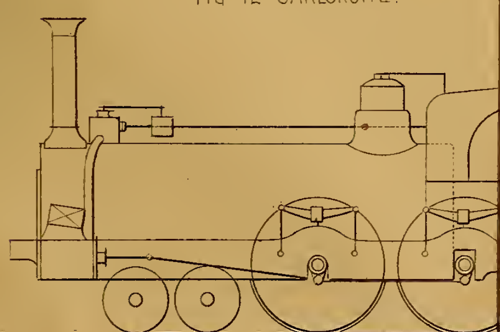
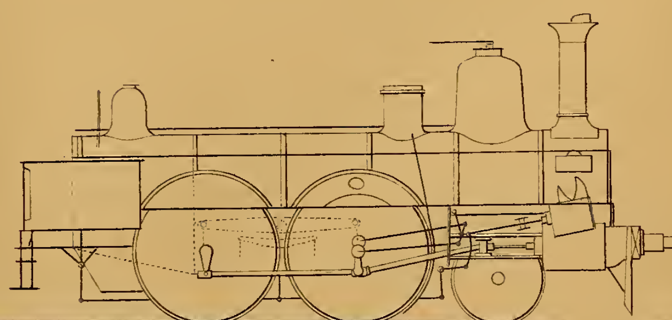


FIG. 15. ORLEANS



W. Smith, C.E. direx.

LOCOMOTIVE ENGINEERING.

DIAGRAMS OF LOCOMOTIVES EXHIBITED

AT THE PARIS EXHIBITION

1867.

FIG 1 STEPHENSON

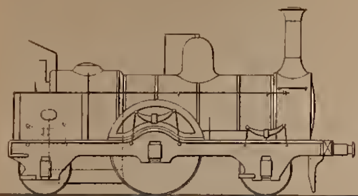


FIG 2 LILLESHAL

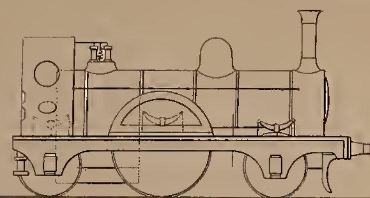


FIG 3 COUILLET.

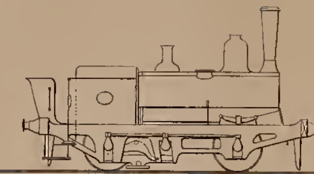


FIG 4 CREUSOT SINCLAIR

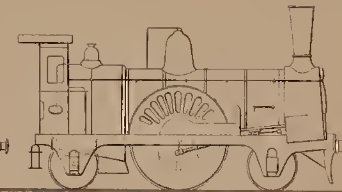


FIG 5 SIGL

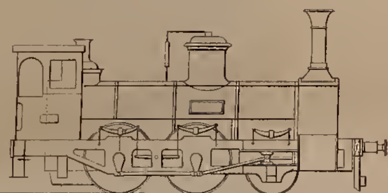


FIG 6 GRANT.

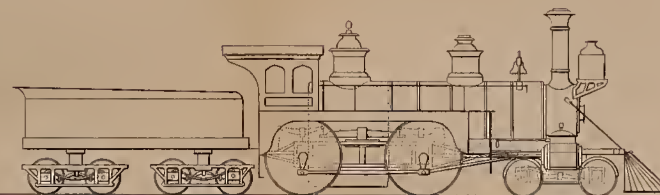


FIG 7 KITSON

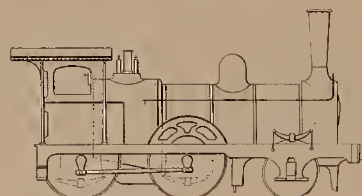


FIG 8 VORUZ

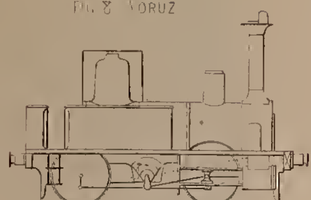


FIG 9 YORKSHIRE ENGINE Co

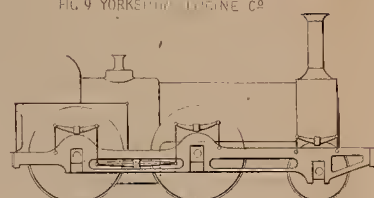


FIG 10 KESSLER

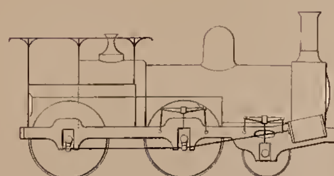


FIG 11 KRAUSS

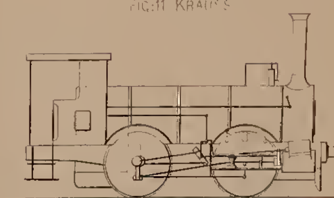


FIG 12 CARLSRUHE

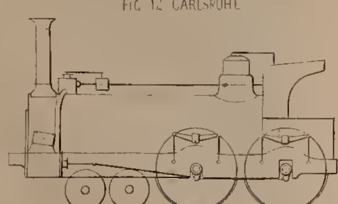


FIG 13 URBAN

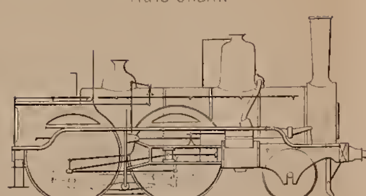


FIG 14 HARTMANN

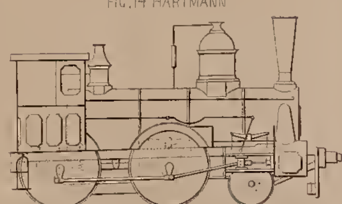
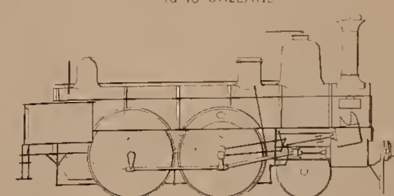


FIG 15 ORLEANS



W Smith, C.E. direx

THE ARTIZAN.

No. 12.—Vol. I.—Fourth Series.—Vol. XXV. From the Commencement.

1st. DECEMBER, 1867.

LOCOMOTIVE ENGINES AT THE PARIS EXHIBITION.

(*Illustrated by Plate* 323.)

The number of locomotive engines brought together in the French Exhibition is far greater than at any previous display. Altbougb there may not he sucb great diversities in appearance or in practice as wben locomotive engineeriug was in its infancy, there is still a sufficient variety to attract attention, wbile in almost every case tbese variations are the result of long experience or are designed for the peculiar exigencies of tbe road for which they are intended. No less than thirty-two locomotives are here assembled, illustrating and affording means of comparison hetween all the principal countries in which they are manufactured, including France, Belgium, Germany, Austria, America, and England. As regards the machiuery proper, but very little difference appears to exist in tbe whole of tbe designs; and, in fact, in tbis respect scarcely any change is observable from those exhibited in London in 1862. Railway travelling at the present day is uo faster (if, indeed, it is as fast) thau it was ten years ago, experience having shown that we have practically attained the highest speed that is compatible with safety and economy—a speed of forty to forty-five miles an hour being the highest tbat is now ever attempted for regular traffic. Of late years, therefore, engineers have turned their attention more especially to the ecouomical working of the locomotive and the saving in wear and tear of the permaueut way. The most obvious improvement in the locomotive was to make it burn coals instead of coke, and various methods have heen adopted for this purpose, one of tbe best of which was illustrated in the Artizan for July last.

But perhaps the principal point to which the attention of railway engineers bas been directed is the economical working of the permanent way; consequently, tbe distribution of the weight of the locomotive over a larger surface, has been the ohject at which they have aimed, and which is well illustrated in the examples before us. In England, where for the most part, railways have hut few heavy gradients, and where the permanent way is constructed in a superior manner, there are not so many difficulties of this nature to be overcome, and consequently not such scope for improvements in this direction as in new countries or mountainous districts. It is, therefore, in tbe examples from Austria and America, and in the locomotives intended for the more mountainous parts of the continent, that we find them constructed with eight or ten wheels coupled, to give them sufficient tractive power to overcome the gradients which they have to encounter, without injury to the permanent way. In connection with tbis point, bowever, anotber arises nearly, if not entirely, antagonistic to the system of long engines with coupled wbeels, viz., the vast number of lines whicb bave been lately made, both in tbe metropolis, as branch lines, and various other cases where tbe curve is so sharp as to necessitate a small wbeel base. This difficulty our engineers have endeavoured to overcome hy using the bogie, but though tbis contrivance enables tbe locomotive to travel with ease round a curve, the wheels are useless for traction purposes unless, perhaps, we except one example, viz., the mountain locomotive by Haswell, of Vienna. In The Artizan for October last, there appeared an engraving, with a description, of an ingenious contrivance invented by Mr. George Smith, which he terms an elastic wheel, and which might probably overcome, to a great extent, the difficulty of ronnding sharp curves, even when the wheels werc all coupled, but we do not know tbat this system has as yet bcen tried for that purpose.

The system of condensation does not appear to be represented in the Exhibition, tbough for ingenuity and novelty it might well bave had a prominent position, especially as this principle will probably have a much more extensive application in the Mont Cenis tunnel and elsewhere for, as Mr. Fowler once aptly remarked, "if a man will hurrow under ground he must breatbe in his ——," well, his internals. As a very complete critical and historical review of locomotive engineering appeared in our pages, extending throughout the entire issue for 1863, we will now only refer to some of the leading dimensions and peculiarities of these more modern examples, as illustrated in the accompanying plate (323), wbich may by advantageously compared witb a similar plate given in The Artizan for May, 1863.

To begin with tbe oldest and most celebrated firm, Messrs. Robert Stephenson and Co., of Newcastle-on-Tyne: Fig. 1 (plate 323) represents one of a number of passenger locomotives which they have built for the Egyptian Railways, this being the 2,012th turned out by the same firm. It is an inside cylinder engine witb single driving-wbeels, and is furnisbed with double frames, tbe driving-axle having both inside and outside bearings, and the leading and trailing-axles outside bearings only. The valve gear is of tbe ordinary shifting link description, and is worked by a very neat arrangement consisting of a combined lever and screw reversing gear. Tbe lever is placed in its usual position and has an eye formed in it through whicb tbe screw passes. The screw is placed horizontally and increases in diameter towards the middle of its length, its outline heing an arc struck with a radius equal to the distance hetwcen tbe upper side of the screw and the bottom pin on which the lever vibrates. Tbe lever is furnisbed with a catch in the usual way, but this catch, instead of falling into the notches of a catcb-plate, enters the thread of the screw, so tbat wben the catch is down in the thread of the screw, the engine can be reversed by turning tbe screw; or, when the catch is raised, the reversal can he effected in the usual way by the lever. Tbe boiler—which is intended to he worked at the bigh pressure of 180lbs. to 190lbs. per square inch—has welded longitudinal joints; thc transverse joints are double rivetted. The followiug are a few particulars:—

Length of grate, 4ft.; width of grate, 3ft. 5·61in.; total grate surface, 13¾ square feet; height of crown of fire-box over fire-bars, 4ft. 10·8in.; size of fire-box, 69 cubic feet; number of tuhes, 161; lengtb of tubes between tube plates, 11ft. 4in.; external diameter of tubes, 2in.; thickness of tubes, ·1 to ·13in.; heating surface of tuhes, 960 square feet; ditto, fire-box, 83 square feet; ditto, total, 1,043 square feet; mean diameter of body of boiler, 4ft.; tbickness of plate, ·50in.; working pressure permitted, 12¾ atmospberes; cubic feet of water contained in boiler (3in. over crown of fire-hox), 88·6 cubic feet; amount of steam space in hoiler (ditto), 50 cubic feet; length of smoke-box, 2ft. 8½in.; width of ditto, 3ft. 11½in.; internal diameter of funnel, 14¼in.; diameter of cylinders, 16in.; stroke, 22in.; number of wheels, 6; ditto, coupled, none; distance between leading and trailing wbeels, 15ft. 8in.; diameter of driving or coupled wheels, 6ft. 7in.; ditto of leading or trailing wbeels, 3ft. 9in.: weigbt on leading axle, 9 tons 13 cwt.; ditto on driving axle, 13 tons 14 cwt.; ditto on trailing wheels, 7 tons 2 cwt.; total weight of locomotive working, 30 tons 9 cwt.; ditto, empty, 27 tons 9 cwt.; tractive force (counting 65 per cent. as effective), 3 tons 16½ cwt.; adhesion at one-sixth, 2 tons 5½ cwt.

Fig. 2 represents au express engine constructed hy the Lillesball Company. This company bave bitherto been known rather as makers of heavy

machinery for the manufacture of iron, such as blowing engines; besides which they are iron and coal masters. It is, however, a very first-class example of an inside cylinder engine. The fire-box has a brick arch and deflector plate for coal burning, and is of very large proportions. The framing, which is very stiff, is formed of two pairs of longitudinal slabs extending the whole length between the buffer beam and back plate. The crank axle, as also the leading and trailing axles are of steel. The slide valves are worked by Allan's patent straight link motion, of the box form. Leading dimensions:—Total grate surface, 18 square feet; number of tubes, 186; length of tubes between tube plates, 11ft. 2in.; external diameter of tubes, 1·75in.; thickness of do., ·062in.; heating surface of do., 980 square feet; ditto fire-box, 96 square feet; ditto total 1,076 square feet; mean diameter of body of boiler, 4ft. 3·12in.; working pressure permitted, 9¼ atmospheres; diameter of cylinders, 16in.; stroke 21in.; number of wheels, 6; ditto, coupled, none; distance between leading and trailing wheels, 16ft. 5in.; diameter of driving or coupled wheels, 6ft. 11ft.; ditto of leading or trailing ditto, 4ft. 2½in.; weight on leading axle, 10 tons 11 cwt.; ditto on driving ditto, 12 tons 14 cwt.; ditto on trailing wheels, 8 tons 8 cwt.; total weight of locomotive working, 31 tons 13 cwt.; ditto empty, 27 tons 14 cwt.

Fig. 3 represents a very curious locomotive by Couillet, of Charleroy. It is intended to work a branch line or for mineral traffic. It has four coupled wheels, and the driving axle, which does not work the wheels direct, has a centre bearing besides two outside bearings. It is an inside cylinder engine, with the valve casings on the outer sides of the cylinders; the valve being worked by only one eccentric. The following are a few particulars: Pressure, 9 atmospheres; diameter of the body of boiler, 3ft. 9in.; number of tubes, 162; diameter of ditto outside, 1⅞in.; length of ditto, 8ft. 4ft.; heating surface in fire-box, 61 square feet; ditto tube surface, 612 square feet; total, 673 square feet; diameter of cylinder, 13⅞in.; length of stroke, 18in.; diameter of wheels, 4ft.; distance between wheels, 9ft. ¼in.; total weight when working, 23 tons 4 cwt.; ditto empty, 19 tons 10 cwt.; contents of tank, 440 gallons.

Fig. 4 represents one of the express engines built by Messrs. Schneider & Co., of Creusot, for the Great Eastern Railway Company, after the designs of Mr. Sinclair and which gave rise to so much discussion respecting the comparative capabilities of English and foreign manufactories, both as regarded price and quality. The subjoined particulars may be found useful:—Length of grate, 4ft. 6⅞in.; width of ditto, 3ft. 5½in.; total grate surface, 15½ sq. ft.; height of crown of fire-box over fire-bars, 4ft. 7·38in.; size of fire-box, 73·71 cubic ft.; number of tubes, 190; length of tubes between tube plates, 12ft.; external diameter of tubes, 1·75in.; Thickness of tubes, ·11in. to ·14in.; heating surface of tubes, 1,045 square ft.; ditto of fire-box, 75 square ft.; ditto total, 1,120 square ft.; mean diameter of body of boiler, 3ft. 11½in.; thickness of plate, .44in. working pressure permitted, 10½ atmospheres; cubic feet of water contained in boiler (3in. over crown of fire-box), 111·3; amount of steam space in boiler (ditto), 37 cubic ft.; length of smoke-box, 2ft. 8⅞in.; width of ditto, 4ft. 7½in.; internal diameter of funnel, 15in. to 18in.; diameter of cylinders, 16in.; stroke, 24in.; number of wheels, 6; ditto, coupled, none; distance between leading and trailing wheels, 15ft.; diameter of driving or coupled wheels, 7ft.; ditto of leading or trailing ditto, 3ft. 7½in.; weight on leading axle, 9 tons. 4 cwt.; ditto on driving ditto, 13 tons 18 cwt.; ditto on trailing wheels, 8 tons 6 cwt.; total weight of locomotive working, 31 tons 8 cwt.; ditto, empty, 28 tons 4 cwt.; tractive force (counting 65 per cent. as effective), 3 tons.; adhesion at one-sixth, 2 tons 6¼ cwt,

Fig. 5 represents a six-wheeled engine, intended for passenger traffic in Russia. It is a four coupled wheel engine having outside frames, the coupled axles having rather clumsy shaped cranks fitted outside and connected direct to the piston rod. The springs of the coupled wheels are connected by compensating levers fitted with adjusting wedges. This engine is also fitted with Schan's injector. The dimensions, &c., are—length of grate, 3ft. 7·3in.; width of ditto, 3ft. 8in.; total grate surface, 14 square feet; height of crown of fire-box over fire-bars, 4ft. 6½in.; capacity of fire-box, 54·5 cubic feet; number of tubes, 150; length of tubes between tube plates, 14ft. 3in.; internal diameter of tubes, 2in.; thickness of tubes, ·09in.; heating surface of tubes, 1,090 square feet; ditto of fire-box, 81 square feet; ditto total, 1171 square feet; mean diameter of body of boiler, 4ft. 2·14in.; thickness of plate, ·59in.; working pressure permitted, 9 atmospheres; cubic feet of water contained in boiler (3in. over crown of fire-box), 118·64 cubic feet; amount of steam space in boiler (ditto), 36 cubic feet; length of smoke-box, 3ft. 9½in.; width of ditto, 4ft.; internal diameter of funnel, 15·35in.; diameter of cylinders, 16in.; stroke, 24·9in.; number of wheels, 6; ditto, coupled, 4; distance between leading and trailing wheels, 11ft. 1in.; diameter of driving or coupled wheels, 5ft. 1⅞in.; ditto of leading ditto, 4ft. 2in.; weight on leading axle, 10½ tons.; ditto on driving ditto, 11 tons; ditto, 11 tons; total weight of locomotive working, 33 tons; ditto, empty, 29 tons 5 cwt.; tractive force (counting 65 per cent. as effective), 3 tons 11 cwt.; adhesion at one-sixth, 3 tons 15 cwt.

Fig. 6 exhibits an entirely different type of engine, the American, though it can scarcely be taken as a type as far as far as regards the ornamentation. It is, undoubtedly, the most remarkable in this respect, of any in the Exhibition. The idea of coating the boiler and chimney with brightly polished German silver is certainly original, though we question whether the addition of a silversmith's apprentice as an engine driver's assistant is not more novel than useful.

This engine appears, at first sight, to be of a great size, but this is very much owing to the "cab," or engine driver's house at the one end, and an enormous lamp and cow-catcher at the other, besides which the rails upon which the engine stands are laid a little above the floor. The engine is on the outside cylinder principle, the Americans adopting that system exclusively, the cylinders being bound directly together under the centre of the smoke-box, a hollow box-like projection from the side of each cylinder, and cast in one with it, being formed for the purpose. The weight of the entire casting containing each single cylinder is nearly one ton. The framing is of the usual American type. A pair of bars extend from the buffer beam to the axle guards of the driving wheels, 3⅞in. wide by 2⅞in. deep., laid flatways, which are intended to transmit longitudinal strains between the cylinder and axle boxes. The axle guards are formed in a separate framing, a pair of somewhat elaborate forgings, 15ft. 6in. long, the lower ends of them being firmly tied together; whilst the upper and lower portions of each of these forgings embrace the forward frame bars, and each of these bars are carried through to the driving axle guard, and the whole held together by bolts. The axle boxes have adjusting wedges on their hind sides, the wedges being of cast iron and having flanges embracing the leg of the axle guard, the flanges of the axle box bearing upon the flanges of the wedges; there are also wedges upon the forward sides of the axle boxes, but these are not adjustable, being in fact only wearing pieces.

The driving axle springs are 3ft. long between the centres of the straps and are each formed of ten plates, 3½in. by ⅜in. steel; they are connected by compensating levers, and at their outer ends have india-rubber blocks between the ends of the spring straps and the frame, these blocks being nearly enclosed in cast iron holders. The wheels are of cast iron, the truck wheels chilled, while the driving wheels have Krupp's steel tyres, cast iron being preferred by American engineers to wrought iron.

The boiler is of ⅜in. plates double rivetted along the horizontal seams, the fire-box being also of iron. The tubes are of copper, and the fire-grate is formed of 2in. wrought iron water tubes with a mud plug in the fire-box casing opposite each end of each tube; these water grates are much liked in America. The top of the outside fire-box casing is flush with the barrel of the boiler. The tube plate is set back from the fire-box about six inches, which is considered a protection to the ends of the tubes, and at the same time it gives more room for combustion. The tubes, which are set in remarkably thin tube plates, are disposed in vertical instead of horizontal rows.

Each cylinder has its own blast nozzle about 3⅝in. in diameter, and rising about halfway only up the tubes, or to 7in. below the centre of the boiler; two blast pipes being preferred to the usual single blast. The chimney is fitted to a cast iron saddle weighing 218lbs., and the smoke-box door weighs 174lbs.! The regulator is a double beat or equilibrium valve worked by a pull-out lever, no American engines ever having crank handles to the regulator. The connecting and coupling rods are grooved out to lessen their weight. The guide bars of cast steel are placed a few inches higher than the level of the piston rod. Rocking shafts, made out of a single forging, are used to work the valves. The ports are 16in. long, and the valve has only ⅞in. outside lap. The eccentrics are of cast iron, and have cast iron straps, which are stiffer and are considered to work quite as well as gun-metal. The links are balanced by a volute spring in a neat little brass case under the middle of the boiler. The piston packing is Dunbar's patent, and the slide valves move on anti-friction rollers.

The cow-catcher is of 1in. round wrought iron rods strongly braced to the smoke box. The head light is of the usual American pattern, with a silvered parabolic reflector 22in. in diameter and 15in. deep. A good head light is expected to show in a dark night sufficient light to enable the time to be seen on a watch, the observer standing 1,000ft. in front. The cab is very handsome, being made of walnut wood and maple. The bell weighs 220lbs., and is always used instead of the whistle at the stations, the whistle itself, as in most American engines, making a most unearthly roar, and being used principally for frightening cattle off the line; its weight is 28lbs. The engine is for the 4ft. 8½in. gauge:—Diameter of cylinders, 16in.; length of stroke, 22in.; diameter of coupled wheels, 5ft. 7in.; diameter of truck do., 2ft. 6in.; diameter of tender do., 2ft. 6in.; total wheel base of engine, 22ft. 3½in.; distance of driving wheels apart, 8ft. 6in.; distance of truck do., 5ft. 9in.; distance from trailing wheels to centre pin of truck, 19ft. 5in.; mean diameter of boiler, 4ft.; number of copper tubes, 142; diameter of tubes, 2in.; length of tubes, 10ft. 11in.; length of firegrate, 5ft. 6in.; width of firegrate, 2ft. 10in.; maximum depth of firebox, 4ft. 11½in.; tube surface, 812 square feet; firebox surface, 84 square feet; grate area, 15·62 square feet.; transverse distance apart of cylinders, 6ft. 2in.; length of connecting-rods, 7ft. 3in.; inside diameter of main steam pipe, 5⅝in.; inside diameter of branch pipes, oval section, 4½in. by 3⅞in.; length of steam ports, 16in.; width of ditto, 1¼in.; width of exhaust ports, 2½in.; lap of valve outside, ⅞in.; ditto inside, $\frac{1}{32}$in.; lead of valve in full gear, ⅛in.; diameter of two blast nozzles, 3⅞in.; diameter of driving axle, 6½in.; diameter of truck do., 4¼in.; driving axle journals, 6½in. by 7⅞in.; truck journals, 4½in. by 8in.; diameter of chimney, 15⅞in.; height of chimney above smoke box, 5ft. 7in.; ditto above rail, 14ft. 1½in.; ditto centre of boiler above rail, 6ft. 4in.; ditto top of cab, about 13ft.; extreme width over cornice of ditto, 9ft. 1½in.

Fig. 7 is a locomotive by Messrs. Kitson and Co., of Leeds, designed for heavy passenger or light goods traffic, and is an excellent specimen both as regards workmanship and design. The engine is an inside cylinder, four coupled one, and has both inside and outside frames. The fire-box is designed for burning coals, the fire-grate being inclined, and a transverse brick arch being placed across just below the tubes. The supply of air is admitted through the fire-hole, the latter being provided with an internal hinged shoot or deflector plate; the fire-door being of the double sliding pattern. The fire-box is of copper ½in. thick, except the tube plate, which is ⅞in. thick. The tubes are of brass placed ·7in. apart. The steam dome is 1ft. 9in. in diameter by 2ft. 9in. high. The safety valves, 2in. in diameter, are on Mr. Naylor's patent, in which the pressure of the spring is applied through the medium of a bell crank lever, the arrangement being such that the pressure on the valve is slightly reduced when it rises, thus enabling the valve to open very freely. The whistles and indicator cocks are all fixed on one casting, so that only one joint on the boiler is required.

The leading axle has outside bearings, the axle boxes having about an inch play to facilitate the engine passing round curves. The journals are of large size, being 6in. in diameter by 9in. long. The leading springs are 3ft. long, and the driving and trailing springs 3ft. 6in. span. The axles are all made of the best Yorkshire iron, and the tyres of crucible steel. The piston rods are of steel, and the pistons of cast iron, each packed with a pair of metal rings. The coupling rods are of steel, and their ends are fitted (on Mr. Ramsbottom's plan) with solid bushes; by which means all provisions for taking up wear by cotters are dispensed with, the bushes, which are lined with white metal, being easily removed when worn. The valve gear is of the shifting link kind, and the engine is fitted with screw reversing gear. The engine-driver is protected by a neat awning fitted with adjustable slides for ventilation.

Length of grate, 4ft. 3½in.; width of grate, 3ft. 4in.; total grate surface, 14½ square feet; height of crown of fire-box over fire bars, 4ft. 6in.; size of fire-box, 60 cubic feet; number of tubes, 140; length of tubes between tube plates, 10ft. 10·12in.; external diameter of tubes, 2in.; thickness of tubes, ·1 to ·13in.; heating surface of tubes, 790 square feet; ditto fire-box, 81 square feet; ditto total, 871 square feet; mean diameter of body of boiler, 3ft. 10·4in.; thickness of plate, ·5in.; working pressure permitted, 12 atmospheres; cubic feet of water contained in boiler (3in. over crown of fire-box), 100 cubic feet; amount of steam space in boiler (ditto), 45½ cubic feet; length of smoke-box, 2ft. 3in.; width of smoke-box, 4ft. 3in.; internal diameter of funnel, 13⅞in.; diameter of cylinders, 16in.; stroke, 22in.; number of wheels, 6; ditto, coupled, 4; distance between leading and trailing wheels, 15ft. 6in.; diameter of driving or coupled wheels, 5ft. 6in.; ditto of leading or trailing wheels, 4ft.; weight on leading axle, 9 tons 3 cwt.; ditto on driving axle, 9 tons 13½ cwt.; ditto on trailing axle, 9 tons 13½ cwt.; total weight of locomotive working, 28 tons 10 cwt.; adhesion at one-sixth, 3 tons 4½ cwt.

Fig. 8 represents a small species of engine, a drawing only of which is exhibited, as used on the line between Vitré and Fougères, and constructed by Voruz, of Nantes, from the designs of M. Forquemot, and intended to take a load of 80 tons up an incline of 1 in 67. The tender has four coupled wheels, which are driven by an intermediate axle connected to the cylinders which are outside. The cranks are balanced by counterweights somewhat similar to the plan adopted by Messrs. Penn in their high-pressure marine engines. It has inside framing. The following are a few of the dimensins:—cylinders, 11·8in. in diameter, and 22in. stroke; diameter of wheels, 4ft. 2¾in.; pressure, 9 atmospheres; number of tubes, 138; length of ditto, 8ft. 2½in.; diameter of ditto, 1⅝in.; weight when working, 17 tons; ditto empty, 14 tons.

Fig. 9 is an express engine built for the Great Northern Railway Company from from the designs and specifications of Mr. Sturrock, by the Yorkshire Engine Company, and is the first engine completed by them at their works, near Sheffield. It is an inside cylinder engine, with four coupled wheels, 7ft. diameter. The driving axle has both inside and outside bearings, the leading and trailing axles having only outside bearings. All the outside bearings are of the double conical shape similar to the bearing in a lathe headstock. The axles and wheel tyres are of steel and the latter are secured to the wheels by Beattie's patent fastener. All the springs are placed above the axles and those belonging to the outside bearings of the driving and trailing axles are connected by compensating beams, each beam having arms 2ft. 3in. and 3ft. 3in. long respectively; the shorter arms being coupled to the trailing axles and the extra weight thus thrown upon the trailing springs compensates for the weight put upon the inside bearings of the crank axle. The copper plates inside the fire-box are all ½in. thick, except the tube plate, which is ⅞in. thick, reduced to ½in. below the tubes. The crown of the fire-box is strengthened by 12 transverse stays, assisted by sling stays fastened to T irons riveted to the crown plate. Gusset stays are used instead of longitudinal tie rods for strengthening the tube plates. A man-hole is formed on the top of the fire-box casing and on its cover the safety valves are placed, and immediately beneath the man-hole are placed six small vertical pipes communicating with the main steam pipe by which the steam is conducted to the regulator. The following are some of the leading dimensions:—heating surface of fire-box including the midfeather, 116·37 square feet; heating surface of tubes,

905·14 square ft.; total heating surface 1021·51 sq. ft.; diameter of chimney, 1ft. 4in.; diameter of cylinders, 17in.; stroke, 24in.; distance apart 2ft. 6in.; steam ports, 1ft. 3in. long by 1½in. wide; exhaust ditto 4in. wide; driving and trailing wheels, 7ft. diameter; leading ditto, 4ft. 3in.; total wheel base, 18ft. 1in.; distance between driving and trailing wheels, 8ft. 6in.; ditto driving and leading wheels, 9ft. 7in.; total weight of engine in working order, 35 tons; weight on driving wheels, 13 tons; ditto on leading ditto, 10 tons; ditto on trailing ditto, 12 tons.

Fig. 10 represents an outside cylinder engine with four coupled wheels, constructed by Emile Kessler, of Esslingen, for the East Indian Railway. The following are some of the principal dimensions:— Diameter of cylinders, 16in.; stroke, 22in.; area of grate, 19 square feet; height of crown of fire box over bars, 4ft. 3in.; number of tubes, 162; outside diameter of ditto, 1⅞in.; length, 11ft.; heating surface of tubes, 1,048½ square feet; ditto of fire box, 102 square feet; total heating surface, 1,150½ square feet; pressure of steam, 120lbs.; diameter of leading wheel, 3ft. 6in.; ditto of driving and trailing wheels, 5ft. 6in.; wheel base, 15ft. 4in.; weight of engine, empty, 29 tons 12 cwt.; ditto when in working order, 32 tons 8 cwt.; ditto on leading wheels, 11 tons 12 cwt.; ditto on driving wheels, 10 tons 8 cwt.; ditto on trailing wheels, 10 cwt. 8 cwt.; tractive force (counting 65 per cent. of effective), 3 tons 5 cwt.; adhesion at one-sixth, 3 tons 13 cwt.

Fig. 11 is a four-wheeled tank engine by Krauss, of Munich, and is the first built at his new works. It is a four-wheeled engine, with outside cylinders, and there are several ingenious contrivances about this locomotive. One of these is the formation of the framing, which is so contrived by being made of the box girder kind, to fulfil the double purpose of tank and engine frame. This is certainly a novelty, but it is doubtful whether it can be kept watertight. The inside of the firebox is made of corrugated plates to allow for the expansion and contraction, thereby avoiding the strain in the corners of the firebox. The reciprocating parts of the engine are all of steel, and made as light as possible; the connecting and coupling rods being hollowed out so as to form a **I** section. The injector is very simple, having no adjustment screws, but which is found to work very well for all practical differences of pressure that may exist. A self-acting lubricator is placed at the top of each valve chest, giving a regular supply each time the steam is shut off in the steam chest. The dimensions are:—Length of grate, 3ft. 1·3in.; width of ditto, 3ft. 3in.; grate surface, 10¼ square feet; height of firebox, 4ft. 6·3in.; cubic capacity of ditto, 43½ft.; number of tubes, 156; length of tubes between tube plates, 11ft. 5⅝in.; exterior diameter of tubes, 1⅝in.; thickness of tubes, ·079in.; tube heating surface, 812ft.; ditto firebox, 49ft.; total ditto, 861ft.; diameter of body of boiler, 3ft. 9·8in.; thickness of plate, ·31in.; working pressure allowed, 10 atmospheres; volume of water in boiler, 109 cu. ft.; ditto steam ditto, 40; length of smoke box, 2ft. 4⅜in.; width of ditto, 3ft. 9½in.; diameter of chimney, 13⅞in.; diameter of cylinder, 14in.; length of stroke, 22in.; number of wheels, 4; ditto, coupled, 4; length of wheel base, 8ft. ½in.; diameter of driving and coupled wheels, 4ft. 11in.; load on wheels, forward, 10 tons 18½ cwt.; ditto, second, 13 tons 18½ cwt.; weight of locomotive working, 21 tons 17 cwt.; ditto, light, 16 tons 6 cwt.; tractive force, 4 tons 15½ cwt.; adhesion at one-sixth, 3 tons 13 cwt.

Fig. 12 is taken from a drawing in the Exhibition of an engine manufactured at Carlsruhe, which is intended for the express traffic in Switzerland. It is an eight-wheeled outside cylinder engine, with four coupled wheels, the four leading wheels running under a bogie. It is fitted with two Giffard injectors. The safety valve is kept down by a weight instead of a spring balance.

Fig. 13 is a good type of locomotive used on the Belgian States Railways for express service, having been built for the line from Anvers to Rotterdam.

This engine is chiefly remarkable for the unusual position of the cylinders, they being stuck outside the framing; the steam-pipe being carried round outside the boiler. The fire-grate is exceedingly large, being 4ft. 7½in. by 4ft. 2½in.; pressure of steam, 9 atmospheres; number of tubes, 223; exterior diameter, 1⅝in.; total heating surface, 1,210 square feet diameter of cylinders, 17·3in.; stroke, 23·6in.; weight of engine (empty), 31 tons.; ditto, when running, 34 tons.

Fig. 14 is an express locomotive by Hartmann, of Chemnitz, for the Luxemberg Railway, where it has been running for six months. It has outside cylinders and the trailing axle runs behind the fire-grate:—Length of grate, 4ft. 1·8in.; width of ditto, 3ft.; grate surface, 13 square feet; height of fire-box, 5ft. 2·1in.; cubic capacity of ditto, 68 cubic feet; number of tubes, 193; length of tubes between tube plates, 10ft. ½in. exterior diameter of tubes, 1⅝in.; thickness of tubes, ·1in.; tube heating surface, 824ft.; fire-box heating surface, 91ft.; diameter of body of boiler, 4ft. 1½in.; thickness of plate, ·59in.; working pressure allowed, 9 atmospheres; volume of water in boiler, 115·8 cubic feet; ditto steam 55 ditto,; length of smoke-box, 1ft. 2·6in.; width of ditto, 4ft. 1½in.; diameter of chimney, 15in.; diameter of cylinder, 16in.; length of stroke, 22in.; number of wheels, 6; ditto, coupled, 4; length of wheel base, 14ft. 5in.; diameter of driving and coupled wheels, 6ft.; ditto of leading, 3ft. 4½in.; load on wheels, leading, 11 tons 4½ cwt.; ditto, driving, 11 tons 4½ cwt.; ditto, trailing, 11 tons 4½ cwt.; weight of locomotive working, 33 tons 13½ cwt.; ditto, light, 30 tons 8 cwt.; tractive force, 2 tons 11½ cwt.: adhesion at one-sixth, 3 tons 15 cwt.

Fig. 15 is an outside cylinder express engine for the Paris and Orleans Railway. It has four coupled wheels, and has a light and elegant appearance.

APPARATUS AND PROCESSES USED IN SPINNING AND ROPE-MAKING, CLASS 55, IN THE PARIS EXHIBITION.

By PETER LE NEVE FOSTER, JUN., C.E.

(*Continued from page* 244.)

ALGERIA.

In this section some effective cotton-gins are exhibited by M. Chanfourier, of Paris. They are adapted for opening and cleaning any kind of staple, whether long or short. The cotton is drawn between a pair of steel rollers, working nearly in contact, and so close as not to allow the passage of an ordinary sheet of paper, and which stop the passing of the smallest seeds which drop through the grating in front of the rollers. The fibres are drawn through by means of wooden rollers covered loosely with leather, which effectually prevent the cotton from being wrapped round the steel rollers. Another pair of leather-covered rollers placed at the back continue the drawing of the fibres through the gin and keep the first pair clean. The chief novelty introduced in this machine is a small fan which sends a current of air on the steel rollers and tends to keep them cool. The machines are cheap, and can be recommended for use in countries where skilled labour is scarce, as they can be put in order by any person of ordinary intelligence.

HOLLAND.

The exhibitors in this department are few in number, and only show some samples of cables and cordage.

BELGIUM.

The manufacture of machinery for the preparation and spinning of textile fibres is the most prosperous in Belgium. Verviers is the principal seat for the construction of woollen machinery, and Ghent for cotton machinery. Machines, both for cotton and wool, are constructed in large numbers at Liège.

A good assortment of cables and ropes of various kinds is exhibited by Vertongen Goens, of Termonde (13). In this town and in the neighbouring communes, upwards of 8,000 persons are employed in ropemaking.

M. Celestin Martin (5) exhibits a complete assortment of woollen machinery, consisting of opening-machine, set of carding-machines, and self-acting mule.

The first machine is for the purpose of opening and oiling the fleece previous to carding. It is provided with self-feeding apparatus somewhat similar to that described in connection with M. Mercier's machinery in the French department. The wool is opened by a revolving beater with iron blades, and passes on a travelling lattice to the oiling apparatus, which consists of a trough containing the oil which is tipped over in a slow and regular manner by a suitable arrangement of gearing, so that the

requisite quantity of oil is poured out on to a revolving brush-roller, and in this manner the wool is sprinkled as it passes under towards a drum covered with short steel points, from which it is delivered in a fit state for carding.

This machine is of great importance for the preparation of wool for the manufacture of cloth and other woollen stuffs; a careless oiling of the fleece causes irregularities in the threads and unequalness in the cloth.

The set of three carding-machines consists of a "scribbler," provided with self-feeding apparatus; the fleece is stripped in the usual manner from the doffer, by a vibrating comb, and formed into a sliver, which is wound into a ball. The "intermediate" card is supplied by forty of these balls of slivers, which are placed in a creel. The sliver delivered by this machine is of twice the size of the former and is wound into a ball. This ball serves to supply the "condenser," the end passing through an eye fixed in an upright is led through another eye, which is made to traverse, by means of an endless leather strap, for the purpose of folding the sliver backwards and forwards on the taker-in or feed rollers. The fleece thus formed is divided into parallel strips by thin steel blades, which are stationary between the carding-cylinder and the doffer; the sixty-four strips and two wasters are then felted by being rubbed between two endless bands of leather stretched on pairs of rollers having an alternate transverse motion; the threads thus formed are wound upon rollers. This machine works about 150lb. of wool per day.

The self-acting mule exhibited by W. Martin may be remarked for the great simplicity in the arrangement of the various parts of the headstock, and which are easily accessible in case of repairs.

Messrs. Houget and Teston, of Verviers (4), have a good display of machinery for preparing and spinning wool, consisting of scouring and rinsing machines, a burring and opening machine, with self-acting arrangement for the fleece. The "lap," or fleece, formed by this machine is rolled continuously on a cloth which effectually protects it from any damage that might occur from carriage, whilst at the same time the evaporation of the oil from it is checked. The "scribbler" card is 44in. in width, with five pairs of workers. The feeding-table is so arranged to take in the "lap," whilst the cloth is wound upon a roller underneath as the lap is unwound. The fleece is stripped in the usual manner from the doffer by a vibrating comb, and formed in a sliver, which is led by an endless feed cloth to supply the "finisher" carding-machine by means of Apperley and Clissold's patent diagonal feeder.

Messrs. Rens and Colson, of Ghent (5), exhibit a throstle-frame for spinning flax.

The Société du Phenix, of Ghent (9), show a carding-machine, drawing-frame, and roving-frame of 112 spindles.

Prussia and the States of Northern Germany.

The principal exhibitor in this department is M. Richard Hartmann, of Chemnitz, Saxony (20), who shows a very complete assortment of woollen and flax dressing machinery.

The wool-carding machinery consists of a double cylinder carding-engine, in which the wool is prepared for the "condenser," and formed into a sliver, which supplies the latter by means of Messrs. Apperley and Clissold's patent feeder. The shaft on which the stripping-comb is fixed is extremely heavy, and the arrangement tends considerably to diminish the vibration of the machine.

The arrangement of the apparatus for felting the threads is altogether novel. The endless leather aprons generally in use are replaced by a pair of leather covered rollers, which are rotated by suitable gearing. An alternate motion is given to them by eccentrics, which can be regulated at pleasure, so that the rubbing may be more or less, as may be required for different qualities of yarn.

A self-acting mule of 180 spindles, for spinning wool, is also shown by Mr. Hartmann.

The flax machinery exhibited by this firm consists of "spreader" for long line. The endless succession of gill bars is well arranged, so as to remedy the noise and wear and tear which ordinarily attend these machines by the too abrupt and violent descent of the faller. The body of the line in this machine is drawn out to from twenty-five to forty-five times its original length.

The second drawing is effected by a drawing-frame for six slivers. The proportion of drawing of the flax in this machine is from fourteen to twenty.

The roving-frame of 70 spindles for bobbins 8in. by 4in.

The carding-machine for tow is 6ft. in diameter and 5ft. in width, with six pairs of workers and clearers and three doffing-rollers. It is fitted with a bell arrangement for stopping the machine when from 300 to 600 yards of sliver have been delivered.

A drawing-frame with three heads for six slivers each. A throstle frame for wet spinning is also shown. It has 176 spindles. The drawing-rollers are in gun-metal, and the weighted rollers of gutta-percha.

Some excellent samples of wire and hempen rope and cables are shown by M. Heekel, of St. Johann, near Sarrebrück (7).

Grand Duchy of Baden.

Three exhibitors only send specimens of hempen and wire rope, also some cordage made from cotton.

Bavaria.

The ropeworks of Füssen send some good samples of twine and fine cords.

Austria.

M. Giradoni, of Vienna (5), exhibits a double-carding machine for cotton; the arrangement of this machine is exceedingly novel, and a great economy of floor space is obviously gained in this manner. The carding-cylinders are placed one on the top of the other, instead of side by side, as is usually done. The workers and cleaners are placed round nearly the entire circumference of the carding-cylinders, the space through which waste can be thrown off between the first and second carding-cylinders being thereby reduced. The fleece is delivered from the first or "breaker" cylinder, to the second, or "finisher, which is surrounded by a pair of rollers and breaker, with six small rollers underneath. The doffer and stripping-comb are of the usual construction, and deliver the finished sliver to the coiling-can. The fly from the first cylinder falls into a box, and the combings from the second cylinder drop out below the machine. The production is stated to be from 150lb. to 220lb. per day, with a total waste of from 4 to 5 per cent. of raw materials used, fly, combings, and strippings included.

The other principal exhibitors from this country are Messrs. Hachnel, Manhardt and Co., of Bielitz, Silesia (6), who show some good samples of card-clothing for woollen goods.

Messrs. Blumenstock, of Reichenberg (2), and M. Angeli, of Trieste, also exhibit good samples of card-clothing for cotton, woollen, and flax machinery.

Switzerland.

The principal exhibitor from this country is M. Rieter and Co. (2), of Winterthur, who has a large display of cotton preparing and spinning machinery. The first and second machines are for the purpose of opening and cleaning the cotton as imported in bales, and forming it into a lap to supply the carding machines. The carding is effected by two machines only—that is to say, double carded, with the intermediate process of lap-doubling. The "breaker" carding machine is furnished with six working rollers and cleaners; the fleece is stripped from the doffer in the usual manner with a vibrating comb, and is contracted and drawn through a tube by means of a pair of rollers into a sliver, which is delivered and coiled in a tin can revolving slowly on its axis.

The lap-doubler is for the purpose of laying the slivers from the "breaker" side by side and forming them into a lap to supply the "finisher" card. Twenty-four cans containing the slivers are arranged on one side of the machine, each end passes through a guide provided with a self-stopping motion, so that in case any sliver should break, the machine is stopped and waste or spoiled work is prevented. The slivers then pass side by side between two pairs of calender rollers; and the lap thus formed is wound on a light wooden bobbin placed in the channel between two fluted rollers. Four of these laps, placed end to end, form a complete lap for the "finisher" card. This machine is fitted with twenty-four self-stripping flats on Wellmann's system. The fleece is stripped in the usual manner from the doffer by the coiling can.

In the drawing frame the fibres of the slivers are straightened and their substance equalised. This machine consists of three pairs of rollers, revolving at different speeds, through which four slivers are drawn into one, and two slivers are thus formed are, by passing through a series of rollers, drawn into one; the single sliver thus formed of eight from the carding machine is deposited evenly and compactly in the coiling can. This machine is fitted with stop motion for stopping the machine should any of the slivers break.

The single slivers are next twisted, for the first time, in the slubbing-frame, into a coarse-thread. This frame is of forty spindles. The slivers are passed from their cans and through three pairs of rollers, the top ones being covered with leather. The slivers then pass to the spindles arranged in a double row along the front of the machine. Each spindle is fitted at its upper end with a flyer, and the slubbing passes through its hollow arm to the bobbin. The spindle and bobbins revolve at different rates, the speed of the bobbin being gradually reduced as the diameter increases by being filled. This is effected by means of a pair of conical drums. The bobbin is lifted by a rack-and-pinion motion, so as to lay the slubbings on the bobbins in even coils. Two slubbings are next twisted together on the intermediate frame of seventy-two spindles; these are, in their turn, doubled and twisted into a roving, on the roving frame of eighty spindles, which are finally spun on the self-acting mule.

Messrs. Wegmann and Co. (5), of Baden (Argan), exhibit some well constructed "silk-throwing" machinery, consisting of winding and cleaning machines for the purpose of winding on bobbins the silk as imported in skeins, and of cleaning the silk at the same time. The skeins are placed upon swifts or reels, the diameter of which can be easily altered to suit the different sizes of the skeins, by sliding out the arms or spokes; the silk is passed between the edges of steel cleaners, consisting of a slit between two steel bars, which is adjustable by screws, to pass the maximum thickness allowed, and to stop fibre of extra thickness. The silk is wound on bobbins, driven by friction of light iron pullies, and is traversed on them by means of a slide rod, having an alternate motion, and carrying small glass rings, through which the silk is guided to the bobbins.

The fibres of silk are next wound and laid evenly together in the doubling-machine previously to being twisted together in the throwing-machine.

Two throwing-machines are exhibited, one for spinning warp and the other weft; also a machine for spinning sewing silk. All these machines are provided with a self-stopping arrangement, in case of breakage of threads.

Some good samples of card-clothing are exhibited by the Fabriques Mécaniques, of Rati, Zurich (3).

M. Honegger (6), of Wetzikon (Zurich), shows various parts of spinning machinery, such as spindles, flyers, &c.

Spain, Portugal, and Greece

make but a poor show in this class, and exhibit only a few rude spinning machines and samples of cordage.

Sweden and Denmark

show excellent samples of cordage from the Establissement de la Marine, at Carlskrona (1), Messrs. Hoffman and Co. (2), of Stockholm, Messrs. Holm and Son, of Copenhagen (1), and M. Thrane and Co. (2) of the same place.

Russia.

Some excellent samples of rope and cables are exhibited by M. Cazalet, of St. Petersburg (1); the dockyard of Cronstadt (2); Jouravleff, of Rybuisk (3); and the Auxiliary Committee of the Caucase, at Tiflis (6), who send specimens of rope and cordage made from bass fibres, wool, and wild hemp.

Italy.

Although the cotton trade is daily becoming more developed in this country, it is a matter of surprise that no preparing or spinning machinery is exhibited.

Ropemaking by machinery in Italy has made but little progress, and the old-fashioned wheels are still used for spinning the yarn and twisting the strands. The combing and preparing of flax and hemp is chiefly performed by hand.

Some well-made machines for winding the silk off from the cocoons, with the usual basins for hot water heated by steam, is exhibited by Messrs. Cariboni (4), of Como; Bataglia, of Varese (5); and Messrs. Traverso, of Alessandria (1).

Turkey and Egypt.

The specimens of rope and cordage and a few spinning implements of rude construction do not require any particular comment.

United States of America.

The contributions from the United States are rather scanty, and consist entirely of preparing machinery for cotton and wool, for which no particular novelty can be claimed.

Mr. H. L. Emery, of Albany, New York (4 and 6), exhibits two saw-gins of similar construction, the small one being worked by hand. In this machine the circular saws are mounted, about an inch apart, on a cylinder, and project about half an inch through a grate in the hopper, or box where the cotton is fed in. In the hopper is a light wooden shaft thickly studded with pointed wooden teeth, revolving freely, for the purpose of presenting the cotton to the action of the saws without pressing; a brush cylinder revolving in a contrary direction clears the saws, and at the same time creates a strong draught. Across the discharging side of the gin is placed a large revolving cylinder of perforated zinc through which the current of air caused by the brush cylinder passes, carrying with it the dust which passes out at the ends. The cotton deposited on the cylinder is stripped by means of a pair of delivery rollers.

The Southern Cotton Gin Company, of Bridgewater, Massachusetts (5), exhibit a 60-saw gin, with brush cylinder.

A somewhat similar machine is exhibited by Messrs. Bates, Hyde, and Co. (2), of Bridgewater, Massachusetts, worked by hand.

Mr. Goddard (3), of New York, exhibits a "Mestizo burring-picker," in which the wool is shaken and beaten till all the burrs fall away. The wool is fed in on the endless lattice, between two taker-in rollers, covered with hook-shaped teeth, to the beater cylinder, covered with bars armed with small teeth, making about 400 revolutions per minute. The wool is then delivered to a smaller cylinder, covered with Garnet's cards, making about 550 revolutions per minute. The wool is stripped from the burring cylinder by a brush roller revolving at the rate of 900 turns per minute; and the fleece is oiled by a revolving brush upon which oil is constantly dropped. The dust is extracted from the wool through the perforated zinc casing over the cylinder by means of an exhausting fan draught. The production of this machine is stated to be about 1,000lb. per day.

Great Britain.

Messrs. Platt and Co., of Oldham (15), exhibit a complete set of machinery for preparing and spinning cotton and wool. For the purpose of separating the staple from the seed they use the Macarthy gin, the principal feature in which is a roller from 4in. to 5in. in diameter, built up of the fibres of jute, in the same way as a brush, and compressed in such a manner as to resemble pasteboard. This roller revolves in front of a hopper, into which the cotton to be cleaned is thrown; the bottom of the hopper is a grating sloping towards the roller, in front of which is placed a thin steel plate, pressing gently against it. The fibres of the cotton are seized and drawn under this plate by the revolving action of the roller until the seeds come in contact with it. A vibrating knife then ascends, and, passing the edge of the plate, pushes off the seeds, which drop through the grating, and the fibres, thus freed, are delivered on the other side.

The cotton is then spread upon the endless feed table of the scutching machine, where it is opened, and freed to some extent of dirt, by a beater revolving in a casing fitted with a series of parallel blades, and with longitudinal slits between the blades through which the dust falls. The cotton is stripped from these cylinders by iron rollers, and formed into a "lap," and partially felted, by being passed between two pairs of calender rollers.

Two carding-machines are exhibited by this firm, one with 45½-in. cylinder, with six pairs of working rollers, and adapted as a single carder for coarse numbers, or, as a "breaker," for preparing slivers for the "finisher."

The other has a cylinder of the same diameter, and is fitted with a pair of working rollers and an endless chain of self-stripping flats. It is specially adapted as a "finisher" for cotton of fine numbers.

A combing-machine is also shown, for laps of cotton 16in. in width; the tuft of cotton from the lap placed at the top of the machine is taken by a pair of nipping jaws and held against a revolving comb, which combs out the short fibres; both ends of the tufts are combed and deposited on a doffing cylinder, in such a manner that the ends are made to overlap each other, and are re-united in a continuous sliver, which is afterwards deposited in a coiling-can on one side of the machine.

The drawing, slubbing, and roving frames of these makers are of excellent construction, and are fitted with the latest improvements.

Two self-acting mules, one for spinning cotton and the other wool, are shown at work. These machines are of the most improved construction, the cam-shaft is driven by conical frictional pulleys, a patent governor or cop-regulator is attached for the purpose of adjusting the winding-on motion to the form of the cop, and it is perfectly automatic in its action. The drawing out motion is provided with an arrangement for stopping, in case of obstruction to the free traverse of the carriage, thereby preventing breakage of bands and other damage to the machinery.

In the throstle-frame exhibited by this firm the common flyer is replaced by the ring and follower. More yarn is produced by this machine with a smaller number of spindles than by the mule, as they can be driven with a greater speed, but the twist is not so regular.

Messrs. Lawson and Sons, of Leeds (11), exhibit some highly important machinery for the preparation and spinning of flax. The carding machine is of considerable weight and importance; the main cylinder, or swift, as it is sometimes called, being 5ft. in diameter, and 6ft. in width, and is surrounded for the greater part of its circumference by working rollers. The tow is supplied on an endless feed lattice, and is stripped from the main cylinder by three doffing rollers, each furnished with stripping-combs, and the three slivers thus formed pass to their respective coiling cans.

The other machines connected with the preparation of flax consist in drawing-frame, spreader, roving-frame of 72 spindles, and a spinning-frame of 200 spindles. These are all of excellent workmanship and design.

Messrs. Combe and Co. (5), of Belfast, also exhibit some good flax machinery, consisting of hackling-machine, roving-frame of fifty spindles, and yarn-reels for winding off lengths of yarn.

The sheets of the hackling machine are vertical, and the hackle-stocks are fixed on the sheets instead of on bars, as is generally the case, and in this way they run more lightly and with less noise and vibration.

The principal feature in this roving-frame is the use of the expanding pulley in place of the conical drum for varying the speed of the bobbin as the yarn is being wound on. This ingenious contrivance for obtaining a variable speed is the invention of Mr. Combe, and consists of two interlocking cones, with the driving-strap running in the groove so formed. An arrangement of left and right handed screws parts or brings together the cones, thereby varying the diameter of the working groove, and, consequently, the speed of the bobbins; and a steadier motion is obtained than with the conical pulley, a matter of great importance in twisting the long fibres of flax slivers.

Messrs. Wren and Hopkinson, of Manchester (17), show some highly-ingenious machinery for winding sewing-silk on cards, and for reeling cotton.

Mr. Ferrabce (7), of Gloucester, exhibits his patent and improved wool-carding machinery, applied to a set of two carding-machines constructed by Mr. Tatham, of Rochdale. The fleece, being stripped in the usual manner from the doffer of the "scribbler," is taken by a system of travelling-aprons, one working at right angles to the other; the fleece by this means is deposited in diagonal folds, crossing each other alternately on an endless apron working at right angles to the axis of the machine, and forming a continuous narrow band about 12 in. in width, which is carried forward mechanically and laid, without stretching, in diagonal folds, one overlapping the other, in a continuous and uniform "bat" of the required thickness, on the endless feed-lattice of the "condenser," where the fleece is divided into a series of parallel strips, which are slightly felted in their passage between two endless leather aprons having an alternate motion across them. The threads are then wound on rollers.

MODELS OF SHIPS AND LIFE-BOATS, CLASS 66, IN THE PARIS EXHIBITION.

By Charles W. Merrifield, F.R.S., Principal of the Royal School of Naval Architecture and Marine Engineering.

(*Continued from p.* 253.)

Rigging.—There is very little exhibited of detailed arrangements relating to tho masts and sails. Thore is one English plan for reducing topsails by rolling the yard; and there is also a French topsail exhibited by Captain Frémont, which is said to be in general use in ships hailing from Havre. A light extra yard, or batten, with a tye of its own, is laced across the sail, at a little more than half its hoight. To reduco sail, the proper topsail-yard is simply lowered upon this. The yard may then be manned and reefs taken and secured in the usual way; after which, if it is only to bo single reefed, the yard is again hoisted. Mr. Cunningham also exhibits his patent chain braces.

Propellers.—For large ships of deep draught the screw-propeller seems to be almost universally adopted, and is to be seen in every variety. When used as an auxiliary, it is, in English practice, either lifted or disconnected from the engine and allowed to revolve freely. But the French not unfrequently use a double-bladed Mangin screw with narrow blades, and fix it in a vertical position, so as to be sheltered by the propeller-post. They find that in this position it offers but little resistance to the water, especially in wooden vessels, in which the propeller-post has a considerable breadth. It is shown in the transport *Creuse*, exhibited by the French Government. Feathering-screws appear to have been generally discarded.

The propeller is now very commonly supported on a single bearing, especially where thore is a balanced rudder, and large bosses are now generally soen. In English practice the boss is usually spherical; but in the *Marengo* the Fronch constructors taper the after-part of it to a point, probably to prevent the accumulation of dead-water. In this case tho screw-shaft has two of Hooke's joints between the engine and the coupling, to allow for the deformation which may take place in a wooden ship.

The twin-screw does not yet appear in vessels of very large sizo, but it appears to be almost universally adopted by the English in small vessels of light draught. All our steam-launches use the double-screw; while the French still adhere to the single screw for these, and work them with a single cylinder. There is an advantago in the very simple engine which they put into these liltlo vessels, all of ours having two cylinders, and some four; but the twin-screw seems better than a single oue for such small craft. Very nice specimens of the regulation steam-launches are exhibited by M. Claparéde and the Forges et Chantiers de la Méditerrancé for the French navy, and by the English Admiralty for our own. The latter has Maudslay and Co.'s four-cylinder twin-screw engines of six-horse power. Messrs. Penn and Messrs. Rennie also exhibit engines for launches, the latter with surface condensers.

The *Waterwitch*, armour-plated steam gunboat, is remarkable for having a hydraulic or jet propeller. She takes in the water from the sea through through a sort of sieve in her bottom. The water is then taken up by a turbine-wheel or centrifugal pump driven by stoam, and thrown ont in a backward direction, with considorablo velocity, through trunks in the sido of tho ship. Tho ship is propellod by tho mere reaction of the water thrown aft, the principle being exactly identical with that by virtue of which a boat is pushed forward by a man who jumps from her stern. She is double-ended, with a rudder at oach end. The propeller is reversed from the deck by turning a sort of hugo three-way cock, without reversing the engines. A speed of 8·8 knots has been attained by this vessel, although her form is not suited for high speed. Thore exist no data for comparing her performance with that of the screw; for, although it has been frequently stated in certain newspapers that she is a sister ship to the *Viper* and *Vixen*, a comparison of the two models (which are close together) will show that, although their extreme dimensions are not very different, their lines are so wholly dissimilar as to render any comparison very uncertain, if not illusory.

Lieut.-Colonel Evelyn exhibits a model of a yacht with an oblique propeller, consisting of a flat plate sliding on an upright post. The plate is pivoted on a frame sliding on this post, so as to allow the after edge to rise or fall until it roaches a stop. The machinery simply drives this plate up and down the post, and the reflection of the water from the oblique surface, or, what is the same thing, the resolved thrust aft, drives the ship forward. Tho plate reverses itself by moans of the resistance of the water as the stroke changes, and thus the resolved thrust is never forward. There is an arrangement to get steering power by turning the post on which the propeller slides, so as to deliver the thrust to port or starboard, instead of right aft.

A screw-propeller is also exhibited, driven by a horizontal wheel and bevel gear. The inventor considers it to be adapted for vessels of shallow draught.

M. Guerbigny-Germeuil exhibits a direct propeller, consisting of a vertical plate driven right aft, and canting edge on for the back stroke. By means of a lazy-tongs arrangement the propeller has five times the stroke of the engine, which is direct. Each propeller has thirty-two distinct bearings and two slides, which come into play at each stroke. There is thus a good deal of friction.

With regard to these and auy other inventions about propulsion, it is useful to bear in mind the following considerations:—

1. That almost any propeller will give more or less propulsion to almost any ship.
2. That tho object therefore is not merely to effect propulsion, but to obtain better performance than is already got by the paddle and the screw, which have a very high performance.
3. That small models are under wholly different conditions from full-sized ships, not only in respect of what is mechanically possible, but in respect of the comparative values of the different elements of power and resistance which enter into tho calculation.
4. That, in general, all propellers drive their vessels simply by the re-action of the water thrown backwards from the propeller, and that their falling off from theoretical efficiency is due to this being wastefully done—that is, to the machinery having to do something more than simply to throw the water aft as quietly and quickly as possible.

Steering Gear: Rudders.—A rudder may be considered under two aspects, as giving roughly an approximation to a curved keel, or as a mechanical engine for turning a ship by moans of that portion of the effect of the impact of the water upon it which can be resolved at right angles to the koel. The latter is tho more convenient for measuring the force, the former is sometimes simpler for getting at the effect. The combined effect of increased length and lateral resistance, and of the tendency of the screw to sweep away the dead water which otherwise would hang round a large portion of the rudder, renders the work of getting over the helm of a modern screw-steamer far greater than that of steering an old-fashioned sailing-ship. In the *Messina* 2½ tons, at a leverage of 1ft., were required to bring the rudder over to 40 deg. when the ship was going nine knots an hour. The *Messina* is not equal either in length, draught, or speed to many of our more recent vessels, and the enormous turning powor required has led to the necessity of mechanical expedients to relieve it. A long tiller, with a purchase, was the first idea, a steering-wheel the next; but it is obvious that any method of applying a sufficient twisting force to the rudder-head will answer the purpose, so long as the rudder-head stands. To obtain this force is simply a question of mechanical work, and the whole of the exhibited steering apparatus may redescribed as simply different methods of applying this twisted couple to the rudder-head, until we come to the balanced rudder, which involves au entirely different principle.

Messrs. Huxham and Brown exhibit a cross-threaded screw—that is to say, a screw with two threads, one right-handed and one left-handed, crossing one another. This works in two half nuts, one of which is fixed to each end of a short lever, which turns the rudder. The half nuts pass one another along the screw, being opposite when the helm is amidships. Messrs. R. Napier and Co., and Messrs. Denny and Co., exhibit two arrangements, differing only in detail, in which a right and left screw works two nuts, from which connecting rods pass to the cross-head of the rudder. A French exhibitor, M. Artige, produces one which differs from that of Messrs. Napier chiefly in being heavier. Mr. Skinner's vertical steering apparatus

has a cross head working up and down by means of a screw of low pitch in a fixed slot which is shaped as a screw of high pitch, so that as the cross-head moves up and down, the fixed-screw slot twists it and turns the rudder along with it. Mr. Hewitt exhibits a rudder which turns by spur gear, working on a spherical boss. Denny's apparatus took five complete turns of the wheel to bring it hard over.

Lumley's patent rudder consists of two pieces hinged together like a folding door. There are various contrivances for making the two parts move together in such a way that the outer part shall make the same angle with the inner part as that does with the ship. There can be but little doubt that the principle is a good one, subject to the difficulties of increased friction and complex gear, with its attendant risk of derangement. The after part is less rigidly connected with the ship, and may thus run some extra risks; but this circumstance appears conducive to the safety of the rudder as a whole. Its chief objection lies in its complexity.

All these methods have more or less tendency to strain the rudder-head and therefore some of our modern naval architects have reverted to the balanced rudder, in which a portion of the rudder is forward of the pivot. In this way it is possible to get rid almost entirely of the twisting strain, so that a child may turn a very large rudder. The chief objection to it is the difficulty of securing it. The principal support is at the neck, and this is in general but insufficiently aided by a pivot resting in a horizontal plate projecting aft from the keel. There is generally no rudder-post, and no after bearing for the propeller shaft. The *Bellerophon* and *Hercules* are thus fitted, and the French ship *Marengo*. In the latter, the forward edge of the rudder is scooped out to allow room for the projecting point of the boss of the propeller, so that the balance of the rudder is got chiefly at the neck and heel. Another form of balanced rudder will be seen in Admiral Halsted's models. In this there is a rudder-post which gives an after bearing to the propeller, and half way between the upper and lower points of support an arm projects from the sternpost so as to give an immediate bearing.

Boat Gear.—The French shed on the *berge* contains a great variety of yokes, tillers, rowlocks, tholes, crutches, horses, belaying-pins, cleats, sheaves, eyes, and other boat and yacht gear. In some of them the strength of the fastenings did not correspond with the scantling of the piece, but generally they seemed very well adapted to their purpose.

The exhibition of boating clothes was wonderful to behold. It is clear that the Parisians do not neglect the decorative part of seamanship.

Vessels for Special Purposes.—A model of a very remarkable submarine torpedo-boat is exhibited by the French Government. It is a very long and sharp vessel, carrying a pole with a torpedo at the end, which it is intended to deposit under the bottom or against the side of the ship which is to be attacked. The motive power is contained in three cylinders of wrought iron, containing air enormously condensed. This works a small screw-engine, and, after having done its work in that, is allowed to escape inside the vessel for the supply of the crew. There is the usual vertical rudder for giving horizontal direction, and there are also horizontal rudders for giving vertical direction. There is also a little apparatus for altering the displacement sufficiently to bring her to the surface if required, and a little life-boat, so contrived that the crew can leave the vessel by it in case of danger or accident. The vessel is in existence at La Rochelle, and it is said that it has actually remained three hours under water. But, from some cause or other, it does not seem to be regarded as of practical utility.

Steam-dredges and mud-barges are exhibited by Messrs. Rennie and Co. and several other English makers. A very interesting set of these is also to be seen in the collection relating to the Isthmus of Suez.

Floating docks are exhibited by Messrs. Randolph and Elder, who show a model and drawings of the one they constructed for the French Government at Saigon; and by Messrs. Rennie and Co. Mr. Edwin Clark's fixed hydraulic lift is also exhibited. In the Netherlands division will be found a model of a camel for floating ships over shallows.

Messrs. Rennie exhibit their hauling slips for the repair of ships. A very ingenious arrangement for this purpose is exhibited by M. T. Labat, of Bordeaux, by which ships are hauled up broadside on.

M. Bertora exhibits an "enveloppe imperméable," which is a sort of mackintosh bag to keep all dirt and weed off a ship when laid up in harbour. The difficulty of getting the bag on, added to the prime cost, makes it a very doubtful economy.

Two arrangements for firing guns under water are exhibited. The principle in both appears to be to have a hole in the ship's side, guarded by a sluice valve, and having an elastic collar, which grasps the muzzle of the gun. I was not able to make out clearly what provision there was for keeping out the water on the recoil of the gun until the sluice valve could be screwed home; nor could I discover any arrangement for taking aim.

Boat-lowering Gear.—Clifford's well-known method is exhibited. There is also a very simple arrangement for the same purpose in the American division (by Messrs. Brown and Level). Both falls are of the same length, and are brought to one winch on board the ship (not the boat), the falls passing between flat pulleys, which thus grip them until both ends run out together. Mr. May exhibits one on a different system in the English annexe. In this the falls are liberated simultaneously by means of a trigger.

Yachts.—The French Government exhibit models of the Imperial steam-yacht *Aigle*, and of Prince Napoleon's yacht *Jérôme Napoléon*. The English Admiralty exhibit their own yachts, *Black Eagle, Elfin, Investigator*, and the Royal yachts *Victoria and Albert, Osborne, Fairy*, and *Alberta*. Messrs. White exhibit a paddle steam-yacht, designed for the Egyptian Government. Of sailing-yachts, several are exhibited by some of the best-known English and French builders, although we miss some well-known names. I do not find the materials for a detailed report in what has been exhibited; for among sailing-yachts the differences are so minute that a race upon equal terms is almost the only effective comparison. I note, however, an increasing divergence of the racing and travelling types.

Pleasure-Boats.—My report upon these must be very short indeed, for the reason that there is very little exhibited that has any claim to striking novelty, except a few vagaries. There is both improvement and selection visible in the models presented, but the only marked novelty is the canoe with the double paddle, and the small steam pleasure-boat. The latter is simply a small edition of the steam-launch, and I have seen one or two of them at work on the Seine. I doubt not that they will be found extremely serviceable for much other work besides pleasure, and the small lake steamers from Sweden are a practical proof of the utility to which this system can be turned. The canoe is exhibited in two forms by Messrs. Searle—as the racing canoe, and, according to the latest improvements of Mr. M'Gregor and the Canoe Club, for a travelling canoe. For a full description of it I must refer to Mr. M'Gregor's published works. Its chief feature is the use of the two-bladed paddle, a right and left stroke being given alternately. Its disadvantages are, that it throws a good deal of trying work on the back of the canooman, and that his hands suffer from the wet running along the paddle, in spite of the ring used to stop the water. It has some very important advantages in the narrow waters for which it is contrived—that it can work in narrow openings which a row-boat could only shoot or pole through, and that the rower looks at his work. This has its value in intricate navigation.

I would give a caution to some of our holiday seekers to be careful how they risk themselves at sea, especially on our western coasts, as they might be tempted to do, by the excellent qualities of those canoes. In the hands of an experienced canoeman, who is also thoroughly acquainted with the coast, a great deal can be done with them; but a solitary person, in any kind of boat, is not safe on the edge of the Atlantic, unless he thoroughly knows the pilotage. The fact is that the propelling power at the command of one man is not sufficient for the wider waters, unless under the exceptional circumstance of calm weather, and this is often treacherous.

It is sometimes amusing to see the curious expedients which are continually being invented to save the trouble of looking over the shoulder occasionally when rowing a boat. There is a contrivance in a shed on the *berge* with this sole object. The inventor puts up a post in front of the rower to which the in-board ends of the sculls are fixed, and then there is a complicated arrangement of brass rods and spiral springs, which enables him to work his paddles the reverse way, with some attempt at feathering. There is, also, a caique from the Levant, with its oars heavily loaded in the loom. These boats are said to pull very fast.

Fishing-Boats are so much mixed up with pleasure-boats and small coasters that a report on one class alone would be very deficient. I, therefore, permit myself to call attention to the very complete set of this species of craft which is to be found in the Norwegian and Swedish exhibitions. It is especially interesting to an Englishman, from the large inheritance of Norse tradition which we possess, especially in these matters. But they fall within class 49, and will, therefore, I presume, be the subject of a different report.

Life-Boats.—The well-established type of this class of vessel is the regular boat of the Royal National Life-boat Institution of England. This has been extremely well considered and approved, after great experience under almost every possible combination of circumstances; and it is probable that, for general purposes, there remains but little that could be altered with advantage. One of the best proofs of this is that the French Ship-wreck Institution has adopted it without any change whatever, except in the carriage on which it is mounted. But a good boat, like a good ship, is to so great an extent a compromise of many qualities more or less sacrificed to others, that there is ample room for advantageous deviation, to suit special circumstances, in many directions. In this way there is much to observe in the models of life-boats, and of boats partially fitted as life-boats. Many of these possess the combination best suited to their requirements.

One of the marked peculiarities of the society's typical life-boat is that of righting itself when capsized. This is one among the least valuable of a boat's qualities, and interferes very much with its carrying power, either for wrecked passengers or for general use, as it depends upon having high

air-cases at the bow and stern and a heavy iron keel. It is consequently abandoned without hesitation in favour of other qualities in paddlebox-boats, and in the life-boats of emigrant-ships. In the man-of-war's life-boat the air-cases are made removable at will, by simply unscrewing an iron strap; so that the man-of-war has thus a good useful whale-boat for general rough weather, and also a self-righting boat for sending out a small crew where a boat is liable to unusual risk of upsetting. For an emigrant-ship, on the contrary, it is clearly better to trust to the boat that will hold most people without upsetting. Accordingly, Mr. White, of Cowes, exhibits nearly every description of life-boat except self-righting ones, and a very instructive collection his set of models will be found. The Life-boat Institution also exhibit their sailing life-boat for Norfolk and Suffolk. The wrecks on these coasts generally take place on the outlying sands, and not on the shore, and the crews are generally taken off by the life-boat from the port to windward. These boats have neither the high air-cases or the excessive sheer of the row-boat, and do not right themselves; but they have the same means of clearing themselves of water. The society also exhibits two models of fishing-boats, with weather-tight hatches instead of decks, and subdivided into compartments. The terrible loss of life that has arisen from the almost exclusive use of open boats for the fishermen of many of our ports shows the necessity of some covering to keep out the water. The division into compartments is a secondary feature, which is not without its disadvantages, being dirty for small vessels; but a longitudinal bulkhead certainly diminishes the risk of capsizing. Among the French boats, besides the one exhibited by the Société, there is an iron life-boat from Havre, built on a model not unlike the ordinary English one, which has seen a good deal of service. There is also a very peculiar one, called the *Prince Jérome*, No. 2, from Havre. A German life-boat, also on the *berge*, is very like our own, Mr. Devrient, of Dantzic, exhibits an excellent sailing life-boat, with air-cases. There is also a model of a life-boat from America, which is said to have done good service. Among the curiosities will be seen a model of Greathead's original life-boat, and of Richardson's tubular life-boat or raft. The defect of all double boats or rafts is that they will not turn to windward.

On the whole, I regard the exhibition in class 63 to be very interesting and instructive, but very far from complete.

INSTITUTION OF CIVIL ENGINEERS.

John Fowler, Esq., President, in the Chair.

The first meeting of the Session 1867-68 was occupied by the reading of a supplement to, and the discussion upon, the paper "Experiments on the Removal of Organic and Inorganic Substances in Water," by Mr. Edward Byrne, M. Inst., C.E., which was read at the close of last Session. The author now gave an account of experiments he had since made on the well-known filtering materials, magnetic carbide, and silicated carbon; and, after recording the results in a tabular form, he proceeded to make a comparison between those substances and animal charcoal.

His experiments were to the effect that the action of the magnetic carbide was exceedingly feeble as regarded the removal of organic and inorganic impurities, and that it did not possess the property of softening the water except to a very small exteet; whereas, this property was possessed in a high degree by the two other filtering materials. Silicated carbon, however, quickly lost this power, and, after a short time, it rendered the water positively harder than it was before filtration. Animal charcoal, in its softening property, was not only more powerful than the silicated carbon, but more permanent in its action; and so far as the experiments went, it continued to remove inorganic matter. After a short time, however, it commenced to give back a portion of the organic impurity which it had previously removed. The silicated carbon too, was found in an equally short time, to give back not only the organic, but also the inorganic, matter which it had previously taken up.

To decide whether the organic matter contained in the water, so far as the nitrogen was concerned, had undergone any oxidation by its passage through these substances, the amount of nitrogen in the original water, and in that passed through each filter, was determined by the process which Professor Wanklyn had recently made known. By this extremely delicate test it was found that, for equal quantities of organic impurity, the amount of albuminous matter in the original and in the filtered waters was precisely the same; which fact was considered a sufficiently clear proof that the organic matter contained in the water had undergone no change by its percolation through these filtering materials.

The author then expressed the opinion that while filtration must ever be considered most valuable for the removal of matter in mechanical suspension, it was practically useless as a means of removing substances in solution. He argued that the deductions to be drawn from these experiments, though made on a small scale, would, by reason of the systematic manner in which they were conducted, be safely applicable to cases of far greater magnitude. He concluded by expressing a hope that the result of these investigations would serve the purpose of pointing out the danger of depending too much on the system generally of filtration, as well as of exposing the inconsistency of bringing home foul water, to undergo a delusive method of purification; instead of adopting the proper and only satisfactory plan of procuring water which was itself naturally pure.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ON THE BIRMINGHAM WIRE GAUGE.

By Mr. Latimer Clark.

The Birmingham wire gauge is a scale of numbers extensively employed, both in this country and abroad, to designate a set of arbitrary sizes of wire varying from about half an inch down to the smallest sizes usually drawn.

The origin of this system and the date when it was introduced appear to be unknown, and as there is no authorised standard in existence, it happens that a great number of gauges have come into extensive practical use under the common name of the Birmingham wire gauge, but which differ from each other to a most serious extent.

A table is subjoined containing the decimal parts of an inch of twelve different wire gauges collected from various sources, and it is probable that many others might be found. The difference in weight of wires of the same denomination, according to different tables, amounts frequently to 10, 15, and even to 20 per cent. and upwards, and this among gauges which are in extensive daily use. The author has, in fact, recently been concerned in a contract in which the choice of one or other of two so-called Birmingham wire gauges, in equally common use and of equal authenticity, would make a difference of more than £8,000 to the contractor.

This discrepancy of gauge has not escaped the attention of practical men. In 1857, Mr. Joseph Whitworth, at a meeting of the Institution of Mechanical Engineers of Manchester, proposed the adoption of a wire gauge in which the number of each size corresponded to its diameter in thousandths of an inch; for example, a wire ·095 inch in diameter would be called No. 95, and so on.

In 1858, Mr. James Cocker, of Liverpool, proposed to introduce a new Birmingham wire gauge, closely approximating to the gauges in ordinary use, but with some of the more glaring irregularities smoothed over, so as to render the gauge more regular in its gradations; he also introduced a very convenient instrument for measuring the sizes of wire in thousandths of an inch, which bears his name, and which has proved a great convenience to practical men; he also employed the word "mil," as signifying the thousanth part of an inch, an innovation which has also been found of extreme convenience in practice.

Before making any suggestions for obviating the inconvenience arising from the great confusion among the guages in common use, I would remark that I agree with others in entirely approving of the system of measurement in decimal fractions of an inch, and I employ this system in my own practice; there is however, so much practical convenience in the use of a limited number of guages, which become familiarised to the memory and to the eye, and the system is in such universal adoption throughout the world, that I see no hope or prospect of its abolition.

Under these circumstances it would appear desirable to bring into use one standard wire-guage, approximating as closely as possible to the present wire-guages, and sufficiently so to render it possible to make the present numbers still available, but formed on a systematic plan, and introduced with sufficient authority to ensure its universal reception.

I am of opinion that if the British Association would appoint a committee to investigate and report upon the subject, and were to issue a guage under their authority, and bearing the title of the "British Association Guage," or "British Guage," that they would confer a great boon on the commercial community, and that the guage recommended by them would soon obtain universal adoption.

I have been unable to ascertain which of the guages given in the subjoined table is entitled to the greatest authority, but I am inclined to attribute greater weight to that given in page 1,013 of Mr. Holtzapffel's book on turning, both on account of his known accuracy and the early date at which his measurements were made.

I have investigated some of the guages with a view to discover the basis on which they were originally formed. The irregularities in gradation are very great, but when plotted they gave a curve approximating to a logarithmic curve, such as would be formed by the constant addition of 10 or 12 per cent. to the diameter of each preceding size.

Upon the whole, I am inclined to think it probable that the original guage was formed by taking as its basis No. 16 bell-wire, having a diameter of $\frac{1}{16}$ of an inch, and that each succeeding size up to No. 1 was formed by successive additions of 25 per cent. to the weight, this would be equivalent to successive increments of 11·8 per cent. to the diameters, and would give a logarithmic curve, which can be extended indefinitely in either direction.

I subjoin a column showing the diameters and sectional areas of wires of the various sizes formed on this basis—that is to say, by constant increments of 25 per cent. in sectional area or weight, and it will be found to approximate so closely to the Birmingham wire-gauges at present in use, that it might be substituted for them without much inconvenience, and I feel confident that if such a guage were issued under the name and sanction of the British Association it would speedily obtain universal adoption.

Table showing some of the Variations existing in the Wire Gauge, as given by different Authorities. Diameters in Decimals of an Inch. | Proposed Gauge.

Number.	From Wells & Hall's Price List.	Number.	W. T. Henley (received from).	Culley's "Handbook of Practical Telegraphy," Second Edition, p. 286.	Culley's "Handbook of Practical Telegraphy," Second Edition, p. 280.	Ryland Brothers (extracted from the "Electrician," vol. i., p. 191.	Ryland Brothers (May, 1866).	Holtzapffel's Book on Turning, p. 1013.	Molesworth's Pocket-Book 1867.	Captain Schaw, R.E., extd. "Electrician," vol. ii., p. 8.	Mr. James Cocker, proposed gauge, 1858.	Supplied by Mr. Bartholomew.	Mr. James Cocker (steel wire), extd. "Electrician," vol. i., p. 286.	Mr. Whitworth on Standard Decimal Measures. 1858.	Diameters deduced from Table of Areas successively increasing by 11·8 per cent.	Areas successively increasing by 25 per cent.	
		00000	·456														
		0000	·425	·454													
		000	·394	·425													
		00	·363	·380	·363	·380											
		0	·331	·340	·331	·340	·326										
		1	·300	·289	·300	·300	·300	·300	·310	·3125	·300	·315	...	·300	·3465	·0943123	1
		2	·280	·276	·280	·280	·274	·284	·280	·2927	·280	·290	...	·280	·3099	·0754498	2
		3	·260	·247	·260	·260	·250	·259	·260	·2708	·260	·264	...	·260	·2772	·0603598	3
		4	.240	·221	·240	·240	·229	·238	·240	·2500	·240	·248	·246	·240	·2479	·0482879	4
		5	·220	·214	·220	·220	·209	·220	·220	·2291	·220	·223	·226	·220	·2217	·0386303	5
		6	·200	·194	·200	·200	·191	·203	·200	·2084	·200	·209	·198	·200	·1983	·0309042	6
		7	·185	·171	·185	·185	·174	·180	·187	·2075	·180	·184	·183	·180	·1774	·0247234	7
		8	·170	·161	·170	·170	·159	·165	·166	·1718	·160	·1685	·175	·165	·1587	·0197787	8
		9	·155	·143	·155	·155	·146	·148	·158	·1562	·140	·150	·160	·150	·1419	·0158229	9
		10	·140	·126	·140	·140	·133	·134	·137	·1406	·130	...	·136	·135	·1269	·0126583	10
		11	·125	...	·125	·125	·117	·120	·125	·1250	·120	·125	·128	·120	·1135	·0101267	11
		12	·110	...	·110	·110	·100	·109	·109	·1125	·110	·1105	·107	·110	·1015	·0081013	12
		13	·095	...	·095	·095	·090	·095	·095	·1000	·100	·0995	·100	·095	·0908	·0064811	13
		14	·085	...	·085	·085	·079	·083	·083	·0875	·090	·085	·092	·085	·0803	·0051848	14
		15	·075	...	·075	·075	·069	·072	·072	·0750	·080	·0755	·079	·070	·0726	·0041479	15
16	·062	16	·065	...	·065	·065	·0625	·065	·065	·0625	·070	·0685	·070	·065	·0650	·0033183	16
17		17	·057	...	·057	·057	·053	·058	·056	·0572	·060	·062	·063	·060	·0581	·0026547	17
18	·043	18	·050	...	·050	·050	·047	·049	·049	·0521	·050	·053	·057	·050	·0520	·0021237	18
19		19	·045	...	·045	·045	·041	·042	·042	·0468	·045	·0445	·047	·040	·0465	·0016990	19
20	·041	20	·040	...	·040	·040	·036	·035	·035	·0416	·040	·0355	·042	·036	·0416	·0013591	20
21		21	·035	...	·035	·035	·03125	·032	·032	·0364	·035	·0325	...	·032	·0372	·0010873	21
22	·032	22	·030	...	·030	·030	·028	·028	·028	·0312	·030	·030	...	·028	·0333	·0008699	22
23		23	...	...	...	...	...	·025	·025	·0281	·025	·0275	...	·024	·0297	·0006959	23
24	·025	24	...	...	·025	...	...	·022	·022	·0250	·022	·025	...	·022	·0266	·0005567	24
25	·023	25	...	...	·023	...	..	·020	·020	·0229	·020	·0225	...	·020	·0238	·0004454	25
26	·019	26	...	...	·019	...	...	·018	·018	·0208	·018	·0185	...	·018	·0213	·0003563	26
27	·018	27	...	...	·018	...	...	·016	·016	·0187	·016	·017	...	·016	·0190	·0002851	27
28	·016	28	...	...	·016	...	...	·014	·014	·0166	·014	·0144	...	·014	·0170	·0002280	28
29	·015	29	...	...	·015	...	...	·013	·013	·0146	·012	·013	...	·013	·0152	·0001824	29
30	·014	30	...	...	·014	...	...	·012	·012	·0125	·011	·0122	...	·012	·0136	·0001459	30
31	·012	31	...	...	·012	...	...	·010	·010	...	·010	·0115	...	·010	·0122	·0001167	31
32	·010	32	...	...	·010	...	...	·009	·009	...	·009	·0105	...	·009	·0109	·0000931	32
33		33	...	...	·0096	...	...	·008	·008	...	·008	·0085	...	·008	·0097	·0000747	33
34	·0096	34	...	...	·0087	...	...	·007	·007	...	·007	·0075	...	·007	·0087	·0000597	34
35	·0087	35	...	...	·0079	...	...	·005	·005	...	·006	·0055	...	·005	·0078	·0000478	35
36	·0079	36	...	...	·0067	...	...	·004	·004	...	·005	·004	...	·004	·0069	·0000382	36
37		37	...	...	·0058	...	...	...	...	...	...	...	...	...	...	...	...
38	·0067	38	...	...	·0042	...	...	...	...	...	...	...	...	...	...	...	...
		39	...	...	·0039	...	...	...	...	...	...	...	...	...	...	...	...
		40	...	...	·0033	...	...	...	...	...	...	...	...	...	...	...	...

ON THE CONSUMPTION OF FUEL.

By MR. WM. PATTERSON, C.E., Perth.

(*Continued from page* 259.)

10. To find the area over the bridge or flame-wall at the end of the fire-grate. To the superficial area in inches of the air passage through a square foot of the fire-grate per second, found by Rule 6, add one-thirtieth part for the increase in volume in the combination of the hydrogen and oxygen, and for the other products of the fuel not previously taken into account, and as the temperature of the furnace may be assumed to be fully 1,000 deg., multiply the total volume by 3, the square root of the quotient is the size of the square in inches for the opening over the bridge or flame-wall for every foot of fire-grate.

Newcastle Hartley.

5·963
5·963
$\frac{1}{30}$)35·567
1·185
36·742
3
$\sqrt{110·226}$ = 10·498 side of square required.

Fordel Splint.

5·336
5·336
$\frac{1}{30}$)28·472
·949
29·421
3
$\sqrt{88·263}$ = 9·394 side of square required.

Of the flues no part of them should be less in cross section than the area over the bridge or flame-wall; they may with advantage be made somewhat larger to give space for deposition of dust, so that the flue at no time may be less than the area over the bridge or flame-wall, and the distance between the chimney and furnace should be as short as possible. The chimney being the part connected with the ordinary furnaces, which provides the power to force the required quantity of air into the furnace, it is necessary to have it of such relative proportions and dimensions as, with the heat going to waste from the boiler, will enable it to perform that work.

11. To find the inside capacity of a chimney; square the rate in feet of air required to enter the fire-grate per second, multiply the product by ·002288; the product is the force in pounds with which the air will enter by the air passage in a superficial foot of fire-grate; multiply the product by ·333, the proportion at least which the air passage between the fire-bars should bear to the bars; the quotient is the force in pounds exerted on one foot of fire-grate. From the degrees of temperature of the products of combustion entering the chimney, which may be assumed at the temperature of steam in the boiler, say 212 deg., subtract the degrees of temperature of the atmospheric air, assumed at 60 deg.; divide the difference by 490·8 (1-490·8ths. being the increment in bulk for every degree of Fahrenheit above 32 deg.); add 1 integer to the decimal found; multiply the sum by 1728; the product is the number of cubic inches of the rarefied air in the chimney, equal in weight to the inches in a cubic foot of air outside the chimney; multiply 535·68, the weight in grains of a cubic foot of air at the ordinary temperature, by 1728, and divide by the last product obtained; subtract the quotient from 535·68 grains; the difference is the weight which a cubic foot of rarefied air is lighter than a cubic foot of air outside; multiply this by ·333, the area of air passage entering the furnace; divide the weight of force exerted on a foot of fire-grate in grains by the last product; the product is the height which a column of rarefied air will counter-balance the pressure on one foot of area of fire-grate.

Newcastle Hartley.

4·352
4·352
18·939
·002288
·04334
·333
212 ·01443
60 7000
490·8) 152 (·309 101.010
1·000
1·309 535·680
1728 1728
535·680
2261·592) 925655·04 409·228
126·452
·333
42·108) 101·01 (2·398

Fordel Splint.

4·554
4·554
20·738
·002288
·047450
·333
·0158
7000
212
60 110·60
490·8) 152 (·309
1·000
1·309 535·68
1728 1728
536·660
2261·592) 925655·04 (409·228
126·452
·333
42·108) 110·66 (2·626

It, however, should be observed that the inside area of the chimney at the top should equal the area of the air passage going through the fire-grate, as the previous calculations in connection with the tables showed a much slower rate of air going through the fire-grate than ought to obtain for proper combustion, for Dr. Ure, in a paper read before the Royal Society in 1863, stated that he found the aerial products of combustion from boiler furnaces flow off with a velocity of fully 36ft. per second, and as these products in that condition follow apparently a fixed law, it is a natural conclusion to come to that if the products of the fuel were supplied with the necessary oxygen at a rate nearly equal to that at which they fly off, more complete combustion would follow, and the full complement of the heat be evolved.

12. To ascertain the height of the chimney; the current of air through the fire bars, the area of fire grate and the pressure of steam being determined on, square the rate required, multiply the product by ·002288, then by the area of feet in fire grate multiplied by ·333; the product is the pressure of the air in pounds on the air passages of fire grate; multiply this product by 7,000 grains, the product is the total pressure in grains; find the difference between the weight of a cubic foot of rarefied air and a foot of cold air, as by Rule 11; divide the total pressure by this difference, the quotient is the cubic content of a column of air to produce the pressure, divide the quotient by the area of air passage through the fire grate, the quotient is the height of the chimney; or if a certain height above 100ft is determined on, divide by the height, and the square root is the side of the square of the chimney at the top; and if it is for a round chimney, multiply the side of the square by 1·128, the product is the diameter of a chimney of equal area. Assume the rate of the air required to be 36ft. per second, the area of the fire grate 21ft., and the pressure of the steam at 50lbs., including the pressure of the atmosphere.

36
36
1296
·002288
281° 2·965
60° 21
490·8)221°(·450
1·000 62·265
·333
1·450 535·68
1728 1728 535·680 20·734
2505·60)925655·040(369·394 7000
166·286(145139·715(872831
Feet high 100)872·831
$\sqrt[2]{8·728}$ = 2·954 = side of square
1·128
3·332 = diameter.
21
·333
Sec. area 6·993)872·831(124·81ft. = height.
$\sqrt[2]{6·993}$ = 2·644 × 1·128 side of square = 2·982 diameter.

It may be premised here that it would be well that the minimum height of chimneys should be 100ft.; not that that height is specially required for draught purposes; the converse is the case, for in our manufacturing towns several of the tapered chimneys would be far more effective were they reduced so far in height; but it would be beneficial inasmuch as it would admit of the deleterious products of incomplete combustion emitted from the chimneys being diffused through the surrounding atmosphere before coming over the surface of the earth, to which

from their denseness, they have a tendency to descend. In regard to boilers generally, the work "Useful Information for Engineers," by William Fairbairn, Esq., C.E., contains, as its title bears, much valuable information. There are, however, a few points on which something may be said. The quantity of water in a boiler, in proportion to the steam room, has always appeared to me to be too large when it is considered that even in those having steam of an elastic force above the atmosphere of 105lbs. the relative volume of steam compared to that of water is 240 to 1. Now, as water in the boiler is required for no other purpose than being converted into steam, and is only expended in doing so, apparently, to be strictly correct these proportions are all that is required, and how a rule could have been thought of for allowing one-half of the cubic capacity for water and the other for steam is not easily explained. Mr. Watt so far remedied this defect by concaving the bottom and sides of the waggon and haycock-shaped boilers, and then in placing a flue through them. It was further remedied in the Cornish, and still further in the marine, tubular, and locomotive boilers, but it does not appear that the bringing of the relative proportions between steam and water nearer each other was the object for which these changes were made, the object being rather to gain increased heating or absorbing surface of boiler. It was, however, overlooked that the apparent heating surface obtained from internal flues and tubes was not nearly all effective, for water boils easiest and raises steam quickest by convection—that is, having the heat applied to the under surface of the boiler—and also when from the length of the boiler, either by a double or triple run, along which the heated products had to travel, a great proportion of the last run was non-effective by the heat being absorbed before passing there. It is therefore necessary that the boilers which have return flues should not be too long, and that in those having three runs of the boiler, the first being in an internal flue, the second should be immediately under the boiler. The Cornish boiler with the double flue is an improvement so far as the flues are concerned, but not as regards the furnace and flame wall. In none of the Cornish boilers, even in those with one flue, is there the proper space above the furnace or over the flame wall to promote perfect combustion. A boiler of the Cornish kind formed something similar to the Butterly boiler, or rather having a fire-box like a locomotive, with tubes three times the size of locomotive tubes, of about 25ft. long—if the tubes are of iron, the conducting power of copper being to iron as 2·4 to 1—would answer. Well, were this kind of boiler so built that the products of combustion could be brought to bear on the underside as well as in the tubes, leaving the boiler at the level of the water line they would be effective in raising steam; or if large flues were preferred to the tubes they might be made oval, supported along the centre of the inside with three rows of vertical pipes, being larger at the top than at the bottom part of the tube, the length of boiler to be from 15ft. to 18ft., and the heated products of combustion to pass from the internal to the under side of the boiler, split, and return by the sides; or another kind of land boiler might be formed of the cylinder form with egg ends, having the water lessened by another portion of boiler inside, rising above the water 6in., the water space between it and the boiler gradually increasing in width up to water line, and thereby bring the water and steam space nearer in proportion to each other, and were the feed water caused to impinge on this steam casing, as it may be called, at several points it would promote the proper circulation of the water when in a state of ebullition, which contributes so much to the generation of steam, give a larger space of steam room, and would prevent priming; studs properly placed would keep the casing in its position. The want of steam room in boilers tends very much to cause the pressure in the boilers to vary, and goes far to assist in some explosions, and were this kind of boiler built on the hung system or oven plan, the flue around the boiler being of the proper sectional area, and the exit flue placed at the top of the water line the full width of boiler and side flues, by the depth to give the proper sectional area equal to the area over the flame wall, the following advantages would be derived from it, viz., that the boiler would hang always in a body of flame or heat from the incandescent fuel, keeping all the heating surface of the boiler of nearly equal temperature, and the heat would be so applied to the heating surface that the water would receive the heat by convection, none of the heating surface having a downward tendency, and no part of the heating surface would be covered with soot, which is generally the case in the last flue of wheel or three run flues—this soot acting the part of a non-conductor, preventing even the little heat that is to be got in these parts of a flue from being absorbed and conducted into the water.

In marine boilers where flues are used they should not have a longer run than 25ft., and should be made narrower at the top, thereby allowing the water space to be widest at the top of the flue, and the nearer the proportion of the steam room and water space are made to the relative proportions they bear in the production of steam so much the better, as saving the space in steam vessels is a desideratum.

Much has been said in favour of large furnaces and slow combustion, but my experience has always been that, when the furnace was not too large, but sufficient to hold the necessary fuel, the space above the fire bars large enough to enable the products of the burning fuel and the oxygen of the air to intermingle properly, the area over the bridge and the flues being of a size sufficient to allow the heat, expanded air, and products of combustion to pass over and through at no higher rate than the air came into the furnace, and that the chimney was of sufficient size inside to produce the necessary draught or pressure at the furnace, that the higher the rate the air came into the furnace, if it did not exceed the rate of 30ft. per second, the more complete was the combustion and the more work done for the fuel burned. A locomotive running at a high speed is always able to raise the necessary steam required for the extra speed by the sharpness of the draught.

And as to the kind of top or finish a chimney ought to have, many fanciful theories are extant, without any good reason for adopting the one instead of the other, for the principal condition for the top of a chimney to be in is to allow the free emission of the rarefied air. This cannot be the case in all states of the weather with some of the forms—for instance, the obelisk top with centre diaphragm has the drawback of presenting a surface to the wind above the top proper of the chimney, the diaphragm being below, therefore the draught of the chimney must be impeded by sudden gusts of wind, impinging on the diaphragm, and forcing itself down the chimney till overpowered by the ascending current. The best form of a top is one having a splay outwards from the inside aperture, so that if the wind strikes it, it will have a tendency to fly upwards and rather assist the ascending current.

The heightening of chimneys has generally been considered as the panacea for all the evil incidental to badly-constructed furnaces and smoky chimneys of dwelling houses.

The height of the chimney produces most effect on draught when advantage is to be taken of the chimney not for combustion but ventilation; for it is a fact well known to all bricklayers, that even in the hottest weather when the air inside the chimney is very cold as compared with the air on the outside, that an ascending current is always in the chimney, and the higher the chimney the stronger is the current; so great and uniform is a current of ascending air in the high chimneys that the inference is that the column of air in the inside can be no denser than the surrounding air at the top of the chimney; if this inference is correct, which I think it is, for on no other theory can the ascending current be accounted for, it does not accord with the present accepted law of the weight of air, which is that the air is like layers of paper lying one above the other, the topmost having merely its own weight, but every layer downwards is bearing the weight of the layers above it, so that at the surface of the earth the bottom layer is supporting a weight equal to 14·7lbs. per square inch. If that law is universal, then the air in the chimney would have the same number of layers as it were as there are on the outside, and when in a colder state would rather have been denser than otherwise, and the current downwards rather than upwards. A case in point is the railway tunnel, in Edinburgh, from Scotland-street to Princes-street—a work with which I was connected—which is 1,008 yards long, and is 116ft. higher at Princes-street than at Scotland-street, but for a considerable length the Scotland-street end of the tunnel is larger in cross section than at any other place; in hot weather, when a larger quantity of rarified air is in the lower end, a strong current of air always descends to Scotland-street.

There is another peculiarity connected with the motion of air in a cold state, that it moves in the reverse way that water does in a syphon, it goes down the short leg and up the long one; and it will do this in a pipe when all around is still, but the motion is much increased if the long leg is made larger as well as longer—this peculiarity of motion in air being induced in a pipe by it having the form of an inverted syphon, the length of the long leg always being sufficiently high to reach a slightly lighter atmosphere, so as to give as much difference in weight as will overcome the friction. The fact was observed by Dr. Chowne, and he took advantage of it by enrolling a patent for ventilating buildings by introducing syphon pipes into them. In his description of the patent he owned he could not account for the action of the air, nor on what principle the motion of the air was induced, neither had he been aware that by making the long leg larger as well as longer the effect would be increased, or the working of the patent might have been more successful, but as it was, it failed.

It is also well known amongst miners that in sinking a shaft, without a brattice wall in it, the smoke of the powder from the shots fired cannot be got rid of, nor pure air obtained to sustain the workmen; but when a brattice wall is put in, and as is generally the case on one side a little longer than the other, the ventilation goes on by the air descending the smallest side and ascending the largest side of the divided shaft. This peculiarity might well be taken advantage of in the mining districts, where good ventilation is so much required, by always having the upcast shaft considerably larger than the downcast; and the mines where carburetted hydrogen exists in great quantities the draught in the upcast might be accelerated without the aid of a furnace by having some of the inflammable gas conveyed in pipes to the upcast shaft, and burnt in jets well up in it; this would help to carry away the noxious gas, save fuel, and improve the draught; the heat evolved from the consumed gas would rarify the air very much; of course the entrance to the upcast should always be equal to the area of the shaft, having sliding doors on it to modify the draught in the mine when required.

I have said that some of the high tapered chimneys would be more effective were they diminished in height so far, which may be illustrated thus: As it is the area of the narrowest part of the chimney multiplied by the height that determines the column of rarified air passing forth from a chimney, take one, therefore, having a sectional area at the top equal to the size of air passage through the fire grate, viz., 6·993ft., or as in Rule 12, the side of the square at the top being 2·644ft., cubic column of air 872·831ft., and height 124·81ft., but were that chimney to be increased in height another 48ft., and have a taper of 1in. in 8ft., the side of square at top would be reduced to 1ft. each way, leaving a sectional area of 2·702ft., which, multiplied by 172·81ft., the increased height only gives a column of rarified air equal to 400ft., as against 872·831ft.

In conclusion, it is of the utmost importance that even the workmen who are engaged in erections where currents of air or gases are concerned should have removed from them the antiquated notions with which they generally are imbued, as to the laws which govern these currents, and should be made acquainted with their nature and laws, for in many cases the workmen, seeing that the instructions they receive or the plans they are working to are the reverse of the notions they have held during life, "that a contracted throat is conducive to a good working furnace," they will have a little of their own will in the matter, and not allow, as they think, the work to be spoiled altogether. They contract some part (I am recording what I have experienced myself), the work is completed, and the result of the working is found not to be what was anticipated, and is only made right when the contracted part is removed. I have been long impressed with the idea that some such work as that had taken

place in forming the air passages where some of the apparent failures took place in the ventilation of the House of Commons. When I had the opportunity of hearing the description of the working of the process of the ventilation of that building, as illustrated by a model in Dr. Boswell Reid's class room, the system appeared perfect; but if by any means the apertures or air passages through which the air of the respective temperatures had to pass, were not in proportion to the densities of the air, perhaps the larger were given for the cold air, and the smaller for the heated, or both might be equal, either of which conditions would destroy to a certain extent the proper ventilation. In the system for ventilating rooms by having an aperture with a valve on it, leading into the chimney of the room, the vent lining above the aperture should be 1in. diameter larger than those below, and kitchen chimney vent linings should be fully two-thirds larger than those for rooms, and no caps should be put on chimneys of a less size than the vent linings.

ON STEAM CULTIVATION—THE ADVANTAGES TO BE DERIVED FROM IT, ITS PRESENT POSITION, AND FUTURE DEVELOPMENT.

By MR. DAVID GREIG.

(Continued from page 256.)

Although it is no doubt an advantage to be able to do the farm operations more cheaply than by horse power, the writer looks upon this as of minor importance, compared with the results referred to in the first part of this paper, and with the increased certainty that will attend the carrying out of the farming business, about which he will say more presently. The cultivation of the soil is a business that requires a great amount of care and attention. A very false idea of a farmer's business is conveyed when it is said that anyone is fit for farming; on the contrary, the writer does not know of any business which requires such minute attention and such keen observation; and this arises mainly from the extraordinary variations in the climate, weather, and soil, and the great effect these variations have upon the crops. Those persons who most carefully observe the state of their land, and never work it except at proper times, will derive the greatest advantage from it. On a farm under horse cultivation, however, this is a very difficult task, as the small amount of profit yielded by farming will not allow the number of horses to be kept that would be necessary to deal with all the land at the right period and in the most economical manner. This inability to perform the work when the land is in its best condition, involves its deterioration until it can scarcely be considered to be in a growing condition, and not unfrequently involves the total or partial loss of a crop. When we reflect that there are only two or three months in the year during which tillage work can be profitably performed, the fact that the horses are sometimes kept going constantly, in order not to fall behindhand with the work, shows that the soil must often be operated upon when it is in a very improper condition. But the person who farms by steam has a powerful and ample force at his disposal, so that he can afford to wait until his land is in a fit state for working; and this force is also an untiring one, which he can work night and day with relays of men if necessary. You may often hear farmers complain that they are behindhand with their work, and they will point out to you a field, or perhaps two fields, in which the crop has been nearly lost simply because it was put in two or three days later than the remainder, or when the land was in a state unfit for its reception. This occurs because the farmer is usually obliged to keep his working force of horses down to the narrowest possible limit, and the consequence is that in some unfavourable seasons he requires twice the power at his disposal to do his work in time. But, as the writer shows, these irritating and expensive difficulties are almost unknown to the man who farms by steam.

Hitherto farming has very rarely been highly successful as a commercial undertaking, and when taken up by commercial men it does not often pay. The reason is that to effect the different operations required in the best possible way entails an expenditure all the year round which cannot be borne by the profits of farming. As the use of steam developes itself, however, farming will become a business in which a man may see his way with some degree of confidence, and be able to calculate beforehand the cost of each operation, and whether he will gain or lose by it. The season and the weather will have only half the control over the crops and tillage operations that they have at present. But, before these results can be effected it is necessary that the very cheapest system of cultivation—cheapest, I mean, as regards the cost per acre—should be adopted, that the tillage should be done at a given time, and at a cost not greater than that of the actual day's work. For instance, if under the present system a farmer were to take each field consecutively, and just calculate beforehand the cost of the different operations required for cultivating it under ordinary circumstances, he would probably find that such an estimate would have to be doubled before it would cover his actual expenditure; and this is in consequence of wet days and other contingencies compelling him to keep his teams and men idle. Such a state of things in an ordinary mercantile business would be ruinous; and this is the great drawback in all calculations connected with farming—wet days have to be paid for exactly the same as dry ones, and often expenses are running on when real harm is being done to the land. Before, also, we can attain the cheapest system of cultivation we must have the farms remodelled, in order to admit of engines and machinery being worked in the most profitable way; and, as the writer has before pointed out, we must have steam implements that will perform every operation required, so as to keep horses off the land altogether, and thus lessen the power required to till the ground.

It is important that the fields should be made of a size to suit exactly the routine of work that the farmer wishes to carry out, and arranged so that all the crops of one kind are together, thus avoiding unnecessary delays and removals. The removal of a number of implements from one field to another entails a loss of time which should be reduced to a minimum by making the fields as large as possible, consistent with the rotation of crops the farmer intends to follow. Some may argue that as their farms consist of different kinds of land, they require a particular crop upon each kind; but the writer believes that when steam is used the advantage of having the whole of the crop in one place more than counterbalances any drawbacks of this nature—except, of course, in very exceptional cases; and, besides, the fact that steam can work one kind of land just as easily as another, will often remove these objections altogether. As an example of the advantages of enlarging fields and pulling down old fences, the writer would refer to the case of a gentleman in Essex—Mr. Prout, of Sawbridgeworth—who, on a holding of 450 acres, by pulling down fences and dividing his farm into seven or eight large fields has gained no less than sixteen acres of arable land—land which was formerly occupied by old straggling fences, trees, and water-courses, and this has been done at a cost which is trifling in comparison with the benefits obtained from the improvements.

The question of roads on a farm has an important bearing on the subject. There is an objection generally made that they take up too much ground, but this is altogether unfounded. The headlands, which are generally trodden down and compressed by horses and carts, require at least twice the cultivation of the other parts of the field, and yield worse crops. There can, consequently, be no profit in their tillage, and the width of a road dividing two fields is of course much less than that of two headlands and the hedge. But, however that may be, by having properly-constructed roads on a farm the cost of taking off the produce is very considerably lessened—say, by a halfpenny per ton on the whole. This would much more than cover the rent of the ground occupied, and prevent any treading on land to be cultivated. When these and such kindred improvements are carried out farming will become a business which any thoughtful and intelligent man may manage with profit, and will be free from most of the vicissitudes which now cause the investment of capital in farming to be looked upon as of so precarious a character.

Besides the advantages to the agriculturist the nation at large will derive great benefit from the increased yield of crops, and also from the fact that the materials to "feed" the power used in tillage will be drawn from the coal-mine or the forest, instead of being taken from the produce of the fields. We shall not be obliged to import so much corn as hitherto, and a larger percentage of the crops will be converted into food for human beings instead of food for horses.

In these days of dear labour a very important point is the reduction in the amount of manual labour required to till the soil, together with the enlightenment of the agricultural labourer, tending to make him use his mind as well as his body. So far as the country is concerned the state of the labour market is becoming a question which every farmer will have to study, for while the labourer justly participates in the progress of the condition of the people of this country, the rise in labour must materially lessen the farmer's profits. Indeed, if wages go on increasing in the same ratio as they have recently done, it will be impossible to farm with a profit at all except by employing such machinery as shall considerably diminish the number of men required.

EXPERIMENTAL RESEARCHES ON THE MECHANICAL PROPERTIES OF STEEL IN ITS PRESENT IMPROVED STATE OF MANUFACTURE.

By WILLIAM FAIRBAIRN, LL.D., F.R.S.

There is probably no description of material that has undergone greater changes in its manufacture than iron; and, judging from the attempts that are now making, and have been made, to improve its quality and to enlarge its sphere of application, we may reasonably conclude that it is destined to attain still greater advances in its chemical and mechanical properties. The earliest improvements in the process of the manufacture of steel and iron may be attributed to Cort, who introduced the process of boiling and puddling in the reverberatory furnace, and the more recent improvements to Bessemer, who first used a separate vessel for the reduction of the metal. To the latter system we owe most of the important changes that have taken place; for by the comparatively new and interesting process of burning out the carbon in a separate vessel, almost every description of steel and refined iron may be produced. The same results may be obtained by the puddling furnace, but not to the same extent, since the artificial blast, of the Bessemer principle, acts in much greater force in depriving the metal of its carbon, and in reducing it to the state of refined iron. By this new process increased facilities are afforded for attaining new combinations by the introduction of measured quantities of carbon into the converting vessel, and this may be so regulated as to form steel, or iron in the homogeneous state, of any known quality.

By the boiling and puddling processes steel of similar combinations may be produced, but with less certainty as regards quality, as everything depends on the skill of the operator in closing the furnace at the precise moment of time. This precaution is necessary in order to retain the exact quantity of carbon in the mass in order to produce by combination the requisite quality of steel. It will be observed that in the Bessemer process this uncertainty does not exist, as the whole of the carbon is volatilised or burnt out in the first instance, and by pouring into the vessel a certain quantity of crude metal containing carbon, any per-centage of that element may be obtained in combination with the iron, possessing qualities best adapted to the varied forms of construction to which the metal may be applied. Thus the Bessemer system is not only more perfect in itself, but admits of a greater degree of certainty in the results than could possiby be attained from the mere employment of the eyes and hands of the most experienced puddler. Thus it appears that the Bessemer process enables us to manufacture steel with any given proportion of carbon or any other eligible element, and thus to describe the compound metal in terms of its chemical constituents.

Important changes have been made since Mr. Bessemer first announced his new principle of conversion, and the results obtained from various quarters bid fair to establish a new epoch in metallurgic manipulation, by the production of a material of much greater general value than that which was produced by the old process, and of, in most cases, double the strength of iron.

These improvements are not exclusively confined to the Bessemer process, for a great variety of processes are now in operation, producing the same results, and hence we have now in the market homogeneous and every other description of iron, inclusive of steel, of such density, ductility, &c., as to meet all the requirements of the varied forms of construction.

The chemical properties of these different kinds of steel have been satisfactorily established; but we have no reliable knowledge of the mechanical properties of the different kinds of homogeneous iron and steel that are now being produced. To supply this desideratum, I have endeavoured, by a series of laborious experiments, to determine the comparative merits of the different kinds of steel, as regards their powers of resistance to transverse, tensile, and compressive strain.

These experiments have been instituted, not only for those engaged in the constructive arts, but also to enable the engineer to make such selections of the material as will best suit his purpose. In order to arrive at correct results, I have applied to the first houses for the specimens experimented upon; and, judging from the results of these experiments, I venture to hope that new and important data have been obtained, which may safely be relied upon in the selection of the material for the different forms of construction.

For several years past attempts have been made to substitute steel for iron, on account of its superior tenacity and increased security in the construction of boilers, bridges, &c. There can be no doubt as to the desirability of employing a material of the same weight and of double the strength, provided it can at all times be relied upon. Some difficulties, however, exist, and until they are removed it would not be safe to make the transfer from iron to steel. These difficulties may be summed up in a few words, viz., the want of uniformity in the manufacture, in cases of rolled plate and other articles, which require perfect resemblance in character, and the uncertainty which pervades its production, requiring careful attention. Time, and close observation to facts in connection with the different processes, will, however, surmount these difficulties, and will enable the manufacturer to produce steel, in all its varieties, with the same certainty as he formerly attained in the manufacture of iron.

In the selection of the different specimens of steel, I have endeavoured to obtain such information about the ores, fuel, and process of manufacture as the parties suppling the specimens were disposed to furnish. To a series of questions answers were, in most cases, cheerfully given, the particulars of which will be found in the tables.

I have intimated that the specimens have been submitted to transverse, tensile, and compressive strain, and the summaries of results will indicate the uses to which the different specimens may be applied. Table I. gives for each specimen the modulus of elasticity and the modulus of resistance to impact, together with the deflection for unity of pressure. From these experimental data the engineer and architect may select the steel possessing the actual quality required for any particular structure. This will be found especially requisite in the construction of boilers, ships, bridges, and other structures subjected to severe strains, where safety, strength, and economy should be kept in view.

In the case of transverse strain some difficulties presented themselves, in the course of the experiments, arising from the ductile nature of some part of the material, and from its tendency to bend or deflect to a considerable depth without fracture.

This is always the case with tough bars whether of iron or steel, and hence the necessity of fixing upon some unit of measure of the deflections, in order to compare the flexibility of the bars with one another, and from the mean value of this unit of deflection to obtain a mean value of the modulus of elasticity, E, for the different bars. This unit, or measure of flexibility, given in the table is the mean value of all the deflections corresponding to unity of pressure and section. The modulus of elasticity has also been calculated from the deflection produced by 112lbs., in order that it may be compared with the results of experiments on cast iron, given at pages 73 and 74 in my work "On the Application of Iron to Building Purposes." In order to determine the resistance of the bars to a force analogous to that of impact, the work in deflecting each bar, up to its limit of elasticity, has been calculated. These results differ considerably from each other, showing the different degrees of hardness, ductility, &c., of the material of which the bars are composed. The transverse strength of the different bars, up to their limit of elasticity, is shown by the amount of the "modulus of strength," or the "unit of strength" calculated for each bar.

Table II., on tensile strain, gives the breaking strain of each bar per square inch of section, and the corresponding elongation of the bar per unit of length, together with the ultimate resistance of each bar to a force analogous to that of impact.

Table III., on compression, gives the force per square inch of section requisite to crush short columns of the different specimens, with the corresponding compression of the column per unit of length, together with the work expended in producing this compression.

Having selected the requisite number of specimens from the different works, the experiments commenced with the transverse strains, which were conducted, as on former occasions, by suspending dead weights from the middle of the bar, which was supported at its extremities, the supports being 4ft. 6in. apart. The apparatus for this class of experiments consisted of a wooden frame, to which was bolted two iron brackets, on which the bars were laid. Immediately over the centre of the bar, at a point equidistant between the supports, a wheel and screw was attached to a scale, on which the weights were placed, 56lbs. at a time; after each weight laid on, the deflections were taken, and the experiment was continued until a large permanent set was obtained. The permanent set was observed at intervals in the following manner—After the deflection produced by the load had been ascertained, the screw was turned so as to raise the scale and relieve the bar of the load, thus enabling the experimenter to ascertain the effects of the load upon the bar and register the permanent set. This operation was conducted with great precision, as may be seen on consulting the tables in the following experiments.

The mathematical formulæ of reduction on the transverse, tensile, and compressive strains have been deduced from the experiments by Mr. Tate as follows:—

FORMULÆ OF REDUCTION.

For the Reduction of the Experiments on Transverse Strain.

When a bar is supported at the extremities, and loaded in the middle,

$$E = \frac{wl^3}{48Kd^2} \quad \text{......} \quad (1),$$

where l is the distance between the supports, K the area of the section of the bar, d its depth, w the weight laid on added to five-eighths of the weight of the bar, δ the corresponding deflection, and E the modulus of elasticity.

When the section of a bar is a square,

$$E = \frac{wl^3}{4\delta d^4} \quad \text{......} \quad (2),$$

These formulæ show that the deflection, taken within the elastic limit, for unity of pressure, is a constant, that is, $\frac{\delta}{w} = D$, a constant.

Let $\frac{\delta_1}{w_1}, \frac{\delta_2}{w_2}, \ . \ . \ . \ \frac{\delta_n}{w}$ be a series of values of D, determined by experiment in a given bar; then,

$$D = \frac{1}{n}\left(\frac{\delta_1}{w_1} + \frac{\delta_2}{w_2} + \ . \ . \ . + \frac{\delta_n}{w_n}\right) \quad \text{......} \quad (3),$$

which gives the main value of this constant for a given bar.

Now, for the same material and length,

$$\frac{\delta}{w}, \text{ or } D \ \alpha \ \frac{1}{Kd^2} \quad \text{......} \quad (4),$$

and when the section of the bar is square,

$$\frac{\delta}{w}, \text{ or } D \ \alpha \ \frac{d^4}{1} \quad \text{......} \quad (5),$$

If D_1 be put for the value of D, when $d = 1$, then,

$$D_1 = Dd^4.$$

$$= \frac{1}{n}\left(\frac{\delta_1}{w_1} + \frac{\delta_2}{w_2} \ . \ . \ . + \frac{\delta_n}{w_n}\right) d^4 \quad \text{......} \quad (6).$$

which expresses the mean value of the deflection for unity of pressure and section. This mean value, therefore, may be taken as the measure of the flexibility of the bar, or as the modulus of flexure, since it measures the amount of deflection produced by a unit of pressure for a unity of section.

Substituting this value in *eq* (2), we get

$$E = \frac{l^3}{4D_1} \quad \text{......} \quad (7),$$

which gives the mean value of the modulus of elasticity where D is determined from *eq* (6). The work, U, of deflection is expressed by the formula,

$$U = \tfrac{1}{2} \times w \times \frac{\delta}{12} = \frac{w\delta}{24} \quad \text{......} \quad (8),$$

where δ is the deflection in inches corresponding to the pressure, w, in pounds. If w and δ be taken at or near to the elastic limit, then this formula gives the work, or resistance analogous to impact, which the bar may undergo without suffering any injury in its material. This formula reduced to unity of section becomes

$$U = \frac{w\delta}{24K} \quad \text{......} \quad (9),$$

If C be a constant determined by experiment for the weight, W, straining the bar up to the limit of elasticity, so that the bar may be able to sustain the load without injury, then

$$\frac{Wl}{4} = CKd \quad \text{......} \quad (10).$$

where $C = \frac{1}{6}$ S, or $\frac{1}{6}$ of the corresponding resistance of the material per square inch at the upper and lower edges of the section

$$\therefore \ C = \frac{Wl}{4Kd} \quad \text{......} \quad (11).$$

When the section of the bar is a square,

$$C = \frac{Wl}{4d^3} \quad \text{......} \quad (12),$$

which gives the value of C, the modulus of strength or the unit of working strength, W, being the load determined by experiment, which strains the bar up to its elastic limit; this value of C gives the comparative permanent or working strength of the bar.

Tensile Strain, &c.

The work, u, expended in the elongation of a uniform bar, 1ft. in length and 1in. in section, is expressed by

$$U = \tfrac{1}{2} \cdot \frac{P}{K} \cdot \frac{l}{L} = \tfrac{1}{2} P_1 \, l_1 \quad \text{......} \quad (13),$$

where $P_1 = \frac{P}{K}$ the strain in lbs. reduced to unity of section, and $l_1 = \frac{l}{L}$ = the corresponding elongation reduced to unity of length.

This value of u, determined for the different bars subjected to experiment, gives a comparative measure of their powers of resistance to a strain analogous to that of impact.

By taking P_1 to represent the crushing pressure per unity of section, and l_1 the corresponding compression per unity of length, the foregoing formula will express the work expended in crushing the bar.

TABLE I.—SUMMARY OF RESULTS OF THE EXPERIMENTS ON TRANSVERSE STRAIN.

No. of detailed Experiment.	MANUFACTURER.	Mark on Bar.	Mean value, Dl, of the the Deflections for unity of pressure and section. By eq. (6).	Mean value of the modulus of Elasticity, E. By eq. (7).	Modulus of Elasticity, E, corresponding to 112lb. pressure. By eq. (2).	Work of Deflection, V, up to the limit of Elasticity. By eq. (8).	Work of Deflection, U, for unity of section. By eq. (9).	Value C, the unit of working strength, By eq. (12).	REMARKS.
								tons.	
1		B1	·0012048	32,672,000	33,047,000	52·280	55·563	6·326	Sunk with 1,150lb.
2		B2	·0013377	29,415,000	25,465,000	59·280	63·003	6·326	„
3		B3	·0012891	30,550,000	32,171,000	72·838	72·690	6·958	
4		B4	·0012581	29,463,000	29,370,000	52·720	54·893	6·134	Sunk with 1,150lb.
5	Messrs. Brown and Co. ...	B5	·0012673	29,248,000	31,510,000	53·480	55·685	6·134	„
6		B6	·0013024	30,224,000	32,361,000	42·068	42·749	5·297	Sunk with 950lb.
7		B7	·0012643	31,135,000	33,523,000	43·900	45·897	5·527	„
8		B8	·0012863	29,335,000	30,686,000	43·358	44·598	5·394	„
9		B9	·001258	31,292,000	31,833,000	39·416	39·416	5·170	„
10		1	·0013081	30,088,000	29,996,000	95·000	85·515	7·504	
11		2	·001637	22,965,000	24,288,000	102·443	84·048	5·904	
12	Messrs. Cammell and Co....	3	·0012612	31,212,000	31,474,000	77·864	78·825	7·413	
13		4	·0013254	29,700,000	30,126,000	44·240	40·902	5·132	
14		5	·0012805	30,742,000	33,205,000	33·750	32·439	4·588	Sunk with 950lb.
15		6	·0012995	30,291,000	31,056,000	37·057	37·657	4·988	„
16		A	·001273	30,923,000	30,940,000	44·741	44·741	5·472	Sunk with 1,150lb.
17		T	·0013124	29,994,000	27,847,000	40·025	40·184	5·505	„
18	Messrs. Naylor and Vickers	S	·0013386	29,407,000	29,385,000	99·463	94·485	7·856	
19		S26	·0012789	30,788,000	29.752,000	82·412	80·788	7·358	
20		O1	·0013886	28,353,000	26,689,000	50·668	48·813	5·432	
21		O2	·001278	30,802,000	20,523,000	64·195	62·684	6·400	
22		O3	·0017814	22,098,000	22,072,000	54·287	47·845	4·691	Sunk with 1,300lb.
23		O4	·0013409	29,368,000	29,718,000	56·433	56·435	6·037	„ 1,250lb.
24	Messrs. Osborn and Co. ...	O5	·0013112	26,398,000	29,610,000	50·079	53·194	5·559	„ 1,300lb.
25		O6	·0016881	23,319,000	23,948,000	31·792	29·393	43·29	„ 1,200lb.
26		O7	·001348	29,188,000	28,013,000	75·776	72·826	6·860	
27		O8	·0013007	30,535,000	29,585,000	50·000	49·406	5·671	„ 1,300lb.
28		BS2	·0021814	29,652,000	29,104,000	70·762	72·199	6·882	
29	Messrs. Bessemer and Co.	BS2	·0012946	30,478,000	28.375,000	42·087	41·261	5·317	Sunk with 1,100lb.
30		BS3	·0015293	29,310,000	28,536,000	32·364	35·008	4·778	„ 850lb.
31		S1	·0012822	30,700,000	31,482,000	52·116	47·452	5·539	
32		S2	·0013412	29,351,000	28,074,000	39·433	37·022	4·808	Sunk with 1,350lb.
33	Messrs. Sanderson Bros....	S3	·0012963	30,368,000	29,858,000	71·390	68·082	6·780	
34		S4	·0013516	29,922,000	29,184,000	51·675	47·230	5·572	
35		S5	·0013333	29,524,000	28,179,000	40·078	37·269	4·907	Sunk with 1,200lb.
36		A	·0013033	30,204,000	30,895,000	46·400	45·369	5·392	Sunk with 1,150lb.
37		B	·0012953	30,390,000	31,297,000	71·087	66·748	6·625	
38		C	·0612598	31,247,000	31,859,000	65·443	65·705	6·718	
39		D	·001287	30,887,000	32,462,000	59·253	60·949	6·337	Sunk with 1,250lb.
40		E	·001303	30,211,000	30,764,000	67·763	65·131	6·576	
41	Messrs. T. Turton and Sons	F	·001302	30,218,000	32,480,000	46·240	44·444	5·440	
42		G	·001295	30,398,000	31,325,000	51·600	52·120	5·861	Sunk with 1,150lb.
43		H	·001382	28,484,000	27,542,000	50·800	49·602	5·570	„ 1,250lb.
44		I	·001368	31,198,000	27,646,000	52·704	54·877	5·788	„ 1,050lb.
45		U	·001325	29,710,000	31,232,000	33·277	31·859	4·561	„ 1,250lb.
46		AX	·001265	31,119,000	32,120,000	115·522	114·600	8·682	
47	The Titanic Iron and Steel Company—Mushet's steel	BX	·001177	33,446,000	34,935,000	51·846	52·892	6·621	
48		CX	·001237	31,823,000	34,879,000	49·960	49·76	5·739	
49		DX	·001261	31,218,000	30,418,000	39·345	36·915	4·699	
50		H1	·001308	30,096,000	33,830,000	77·944	77·917	6·860	
51	The Hæmatite Iron and Steel Company	H2	·001280	30,754,000	34,443,000	14·242	14·383	3·108	
52		H3	·001319	29,717,000	32,717,000	20·155	19·757	3·540	

TABLE II.—SUMMARY OF RESULTS OF EXPERIMENTS ON TENSILE STRAIN.

No. of detailed Experiments.	MANUFACTURER.	Mark on Bars.	Specific Gravity of Specimen.	Weight laid on in lb. producing rupture.	Breaking Strain per square inch of section.		Corresponding Elongation per unit of length, or value $V = \frac{v}{L}$	Value of U, or work producing rupture. By eq. (13).	REMARKS.
					lb.	tons.			
1	Messrs. Brown and Co.	B1	...	31,849	68,404	30·53	·0056	191	Broke in neck.
2		B2	...	39,784	91,520	40·85	·0150	686	,,
3		B3	...	30,371	106,714	47·64	·0143	763	,,
4		B4	...	49,564	116,183	51·86	·0337	1957	,,
5		B5	...	31,916	110,055	49·13	·0375	2063	,,
6		B6	...	39,764	91,972	41·05	·0837	4522	,,
7		B7	...	39,799	92,555	41·31	·0406	1878	,,
8		B8	...	22,211	76,474	34·27	·0968	3715	Broke 1in. from neck.
9		B9	...	17,171	59,538	26·57	·0762	2268	Broke in centre.
10	Messrs. Cammell and Co.	1	...	31,916	110,055	49·13	·0177	974	Broke 2½in. from neck.
11		2	...	31,871	109,072	48·69	·0206	1123	Broke in neck.
12		3	...	35,066	120,398	53·75	·0281	1691	,,
13		4	...	41,344	96,665	43·15	·0250	1208	,,
14		5	...	38,224	89,121	39·78	·1437	6403	Broke near centre.
15		6	...	23,891	81,483	36·37	·1200	4888	,,
16	Messrs. Naylor & Vickers	A	...	25,571	88,665	39·58	·0625	2770	Broke in centre.
17		T	...	39,784	91,520	40·85	·0475	2173	Broke 2¾in. from neck.
18		S	...	57,374	134,145	59·87	·0100	670	Broke in neck.
19		S26	...	35,066	118,066	52·70	·0287	1694	,,
20	Messrs. Osborn and Co.	O1	...	43,129	98,942	44·17	·0156	771	Broke in neck.
21		O2	...	51,899	123,686	55·21	·0318	1966	,,
22		O3	...	49,549	115,849	51·71	·0298	1726	,,
23		O4	...	41,344	98,790	44·10	·0181	894	,,
24		O5	...	44,464	103,116	46·03	·0431	2222	,,
25		O6	...	38,224	87,931	39·25	·0243	1068	,,
26		O7	...	36,664	85,724	38·26	·0037	158	,,
27		O8	...	47,764	111,676	49·85	·1062	5930	Broke in centre.
28	Messrs. Bessemer and Co.	BS1	...	42,904	103,085	46·02	·0187	963	Broke in two places.
29		BS2	...	38,224	88,175	39·36	·1093	4818	Broke near centre.
30		BS3	...	33,439	78,606	35·09	·0981	3855	Broke in centre.
31	Messrs. Sanderson Bros.	S1	...	31,849	83,484	37·26	·0187	780	Broke in neck.
32		S2	...	46,054	107,940	48·18	·0318	1716	,,
33		S3	...	42,904	107,182	47·84	·0275	1473	,,
34		S4	...	32,689	75,199	33·57	·0137	515	,,
35		S5	...	44,464	103,960	46·41	...	1782	,,
36	Messrs. T. Turton & Sons	A	...	41,344	100,155	44·71	·0312	1562	Broke in neck.
37		B	...	38,164	87,552	39·08	·0106	464	,,
38		C	...	41,344	95,372	42·57	·0181	863	
39		D	...	31,849	80,273	35·02	·0018	72	,,
40		E	...	44,611	102,915	45·94	·0181	929	
41		F	...	44,464	102,567	45·79	·0206	1056	
42		G	...	46,054	106,237	47·42	·0243	1290	,,
43		H	...	38,224	87,471	39·04	·0131	572	,,
44		I	...	41,344	97,994	43·74	·0193	945	,,
45		U	...	31,849	73,266	32·70	·0087	318	,,

TABLE III.—SUMMARY OF RESULTS OF THE EXPERIMENTS ON COMPRESSION

No. of detailed Experiments.	Manufacturer.	Mark on Bars.	Greatest weight laid on per square inch.		Corresponding compression per unit of length.	Value of U, or work expended in crushing the bar, by eq (13).	Remarks,
			lb.	tons.			
1	Messrs. John Brown and Company	B1	225,568	100.700	·253	28,533	One very slight crack appeared.
2		B2	,,	,,	·263	29,592	No cracks.
3		B3	,,	,,	·183	20,591	One very slight crack of outside skin.
4		B4	,,	,,	·293	32,968	No cracks.
5		B5	,,	,,	·243	27,342	,,
6		B6	,,	,,	·403	45,345	,,
7		B7	,,	,,	·443	49,846	Three large cracks, with several smaller.
8		B8	,,	,,	·493	55,472	Much cracked.
9		B9	,,	,,	·553	62,223	,,
10	Messrs. Charles Cammell and Company	1	225,568	100,700	·233	26,217	No cracks.
11		2	,,	,,	·263	29,592	,,
12		3	,,	,,	·313	35,218	,,
13		4	,,	,,	·303	34,171	Very slight cracks.
14		5	,,	,,	·433	48,721	No cracks.
15		6	,,	,,	·493	55,172	,,
16	Messrs. Naylor, Vickers, and Company	A	225,568	100,700	·423	47,596	No cracks.
17		T	,,	,,	·388	43,758	,,
18		S	,,	,,	·153	17,255	,,
19		S26	,,	,,	·183	20,591	,,
20	Messrs. Osborn and Co., Sheffield	O1	225,568	100,700	·203	22,841	No cracks.
21		O2	,,	,,	·243	27,342	,,
22		O3	,,	,,	·253	28,467	,,
23		O4	,,	,,	·263	29,592	,,
24		O5	,,	,,	·323	36.344	,,
25		O6	,,	,,	·323	36,344	,,
26		O7	,,	,,	·193	21,716	,,
27		O8	,,	,,	·333	37,469	,,
28	Messrs. Bessemer and Co.	BS1	225,568	100,700	·223	25,092	No cracks.
29		BS2	,,	,,	·443	49,846	,,
30		BS3	,,	,,	·473	53,222	,,
31	Messrs. Sanderson Bros....	S1	225,568	100,700	·398	44,783	Two large cracks.
32		S2	,,	,,	·303	34,093	Very slight crack.
33		S3	,,	,,	·283	31,843	No cracks.
34		S4	,,	,,	·323	36,344	Several slight cracks.
35		S2	,,	,,	·333	37,469	Much cracked.
36	Messrs. Thomas Turton and Sons	A	225,568	100,700	·283	31,843	No cracks.
37		B	,,	,,	·193	21,216	,,
38		C	,,	,,	·343	27,342	,,
39		D	,,	,,	·263	29,592	,,
40		E	,,	,,	·233	26,217	,,
41		F	,,	,,	·253	28,467	,,
42		G	,,	,,	·293	32,968	,,
43		H	,,	,,	·273	30,718	,,
44		I	,,	,,	·273	30,718	Very slightly cracked.
45		U	,,	,,	.293	32,968	No cracks.

Abstract of the Results of Tables I., II., and III.

Transverse Strain.—Table I.

The results of these experiments show that, within the elastic limits, the deflections are in proportion to the pressures. For example, in Experiment 1, the deflections are almost exactly expressed by the formula, $\delta = \cdot 001361\ w$, where the constant ·001361 is the mean, D_1, of all the deflections for a unity of weight, derived from formula (3). By aid of this principle the value of the weight, w, with its equivalent deflection, corresponding to the elastic limit, was determined.

The mean value of the deflection corresponding to unity of pressure and section may be taken as the measure of the flexibility of the different bars. In general, the least flexible bars give the highest values of E and C, and, other things being the same, or nearly the same, the most flexible bars give the highest value of u, the work of deflection corresponding to unity of section.

The bars of some of the experiments, with more than an average flexibility, gave very high values for C, the working unit of resistance to transverse strain, showing their great value when applied to the springs of carriages and other constructions, where flexibility and strength should be combined. Such bars as those of other experiments, with less than an average flexibility, gave at least an average value for C, showing their applicability to all constructions where rigidity and strength are required. And so on to other cases.

The mean value of E, the modulus of elasticity, given in column 5, taken for thirty of the best specimens, is 31,000,000 nearly, whilst the mean taken for a like number, in column 4, is about 32,000,000. This modulus exceeds that of wrought iron by more than the thirtieth part. Steel, having a much greater flexibility than wrought iron, accounts for the approximation of their values for the modulus of elasticity. The bars that have the greatest flexibility, or the greatest value of D_1, other things being the same, have the least value for the modulus of elasticity.

The values of u, or the work of deflection for unity of section up to the elastic limit, may be taken as measures of the qualities of the bars where flexibility and strength are required.

The bars generally exhibit very high powers of resistance to transverse strain. The mean value of the unit of working strength, C, given in column 9, taken for one half the number of experiments, is 6·83 tons, and for the remaining half (omitting the last two experiments) this constant is 5·23 tons, giving a general mean of 6 tons. In the model tube of the Britannia and Conway bridges, the value of this constant for *breaking weight* is 6·7 tons.

It was next shown that, taking 11 tons per square inch as the mean value of the compressive and tensile resistance of wrought iron at the elastic limit, the value of C, in this case, will be less than two tons, and thence it followed that the transverse strength of these steel bars will be about three and a half times the strength of wrought iron bars of the same dimensions.

In order to determine the relative value of the kinds of material undergoing transverse strain, he then supposed two bars of the same length, one steel and the other iron, having the same strength, to be similar in their transverse sections, the strengths of bars of similar section are as the cubes of their depths,

$$d_1 = \sqrt[3]{\frac{C}{C_1}} \times d = 3\cdot5\tfrac{1}{3} \times d,$$

where d is the depth of the steel bar, d_1 that of the iron bar, and $\frac{C}{C_1} = 3\cdot5$, the ratio of their units of working strength.

But as the areas of similar section are in the squares of their like dimensions,

$$\frac{\text{Section iron bar}}{\text{Section steel bar}} = \frac{3\cdot5\tfrac{2}{3}\,d^2}{d^2} = 3\cdot5\tfrac{2}{3} = 2\cdot3052.$$

Now, taking the cost of iron at £7 per ton, and that of steel at £12, we have, for the relative cost of the two materials of the same strength,

$$\frac{\text{Cast iron}}{\text{Cast steel}} = \frac{7 \times 2\cdot3052}{12} = \frac{16\cdot1363}{12} = 1\cdot3447,$$

that is, the cost of the iron would be about one and one-third times that of the steel.

In the case of railway bars and such constructions, besides this saving in the cost of material, it must be borne in mind that the steel rail would last four times as long as the iron rail.

Tensile Strain.—Table II.

Taking the mean of the results of the experiments on thirty of the best specimens, we find the mean tenacity per square inch = 47·7 tons.

Now, if we take 25 tons per square inch as the tenacity of the best English hammered iron in bars, it follows that the tenacity of these steel bars will be about twice (1·91 times) that of the iron bars.

Economic Use of the Material.

For bars of equal strength, undergoing tensile strain, the iron bar should be about twice the section of the steel bar; now, if the cost of steel be £12 per ton, and that of iron £7, then the cost of the iron would be more than $1\frac{1}{10}$ times that of the steel; in this case, therefore, the steel would be the more economical metal. The saving per ton of material would be £1·37, or £1 7s. $4\frac{3}{4}$d. The work producing rupture in the different specimens is very variable, owing, probably, to some extent, to the errors arising from the determination of such exceedingly small elongations. This irregularity would have been avoided, if the specimens had been of greater length so that the elongations might have been ascertained with greater accuracy.

The greatest value (6,400) of this work of elongation is given in Experiment 14, where the breaking strain of the specimen is below the average, being only about 40 tons per square inch.

The specimen which had the greatest tenacity, viz., about 60 tons per square inch, required only 670 units of work to produce rupture; this arises from the very small elongation, viz., ·01, which the bar sustained at the point of rupture.

The ultimate elongations are unaccountably variable, and seem much below what might have been expected; even the greatest elongation, ·1437, given in the Table, is below the average for iron bars, whilst the least elongation, ·0037, produced by a strain of $38\frac{1}{4}$ tons per square inch, is only about the fiftieth part of this average.

Compression.—Table III.

Thirty-two of the bars supported each a pressure of 100·7 tons per square inch of section, without undergoing any sensible fracture, whilst twenty-three bars were more or less fractured with this pressure. The mean value of the compression per unit of length, taken for twenty-four of the best specimens, is ·372, whilst the mean, taken for the remaining specimens, is ·232, giving a general mean deflection of ·302. The work expended in crushing the material in short columns is remarkably large. The mean value of u, taken for twenty-six of the best specimens, is 41·300, whilst the mean, taken for the remaining specimens, is 25·409 giving a general mean value of 33·400.

If 6,000 be taken as the value of u, in the case of tensile strain, then the work expended in rupturing the material by compression will be five and a half times the work expended in rupturing the material by extension.

Tensile and Compressive Resistances Compared.

Taking the mean tensile resistance to rupture 47·7 tons per square inch, it follows that their resistance to compression is more than double (2·1 times) their resistance to extension; thus, $\frac{100\cdot7}{47\cdot7} = 2\cdot1$. Hence it follows that the most economic form of a steel bar undergoing transverse strain would be a bar with double flanges, having the area of the bottom flange about double that of the top flange.

This conclusion is borne out by the results of experiments on transverse strains, where the strain per square inch of the material at the elastic limit is equal to 40·98, or 41 tons nearly, but the mean breaking strain per square inch by extension = 47·7 tons, clearly indicating that the compressive resistance in the former case was considerably in excess of the tensile resistance.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

ADDRESS DELIVERED TO THE SOCIETY

By B. Haughton, Vice-President.

The past year has been an eventful one in the history of the profession; a year of stagnation and of languor, of unfulfilled expectations, and of blighted prospects. Owing to a run of extraordinary prosperity in the nation, caused by the vast progress of inventions; owing to the discovery of gold, coal, and iron, above what the most sanguine could have anticipated; and owing to a widely-extended system of education, the financiers found themselves of late possessed of the sinews of war to a practically unlimited extent. They devised a new and expansive machinery for the purpose of facilitating the progress of events, and the investment of their gains in the form of financial companies, credit and banking societies, &c. They went ahead too fast, and the upshot is collapse. Looking at things as they are, from an engineering point of view, however, we must not despond; capital, as it accumulates, must somehow find an investment in the long run, and there is hardly any known means open to it that can be utilised without the aid of the engineer. As long as there is capital, so long there will be need for the engineer.

The subject of the education of the engineer is one that has been frequently discussed by this society.

It has been said that if engineering were placed on a level with the three learned professions, that is to say, that if the universities and certain colleges of engineers were empowered to grant degrees qualifying persons to act as civil engineers, the profession would thereby be relieved of a large portion of the incapacity which now holds on by it. The public would be more certain of having their works economically and permanently executed, and in short that it would become a better educated, more select, and honourable profession. Whether or not such would

become the case, I am hardly prepared to say. I am informed that in France such degrees are granted by the State Department of *Ponts et Chaussées*, which has produced a large number of famous engineers; but that there also men of much ability, and who thoroughly enjoy the confidence of the investing public in that country, who are not possessed of any kind of state degree.

The comparison of the profession of engineering with other professions may be productive of some advantage in discussing the subject of an engineering education; while making such, it must be borne in mind that there are many points of difference, for instance, the lawyer and the clergyman are essentially men of words—the cloister and the lecture-room are fit places wherein they may obtain titles and degrees to practice their professions.

The engineer is, on the other hand, a man of action, and of deeds rather than of words. His cloister is the graving dock, the tunnel, the ship's interior, and the workshop. The canopy of heaven is the dome of his lecture room, the rugged upturned earth, the rockshelf, and the sea-bed its floor. What corporation or university is competent to confer degrees of proficiency in such arenas as these? Here lies the difficulty; the well-educated engineer has received two educations, the one in the cloister, the other abroad and on works. This double education cannot be acquired at an university; in short, it can only be acquired by a many-sided man. I must say that I am for an university education for the engineer; let him there take a degree of proficiency in the theory of his profession, in drawing, and in the use of surveying instruments; but so far his work is less than half done. Without doubt, the most important part of it remains, the study of works and practice thereon. It must be confessed it remains yet to be discovered how the precepts of the cloister are to be given without clashing with what must ever be the mainstay of his knowledge, the precepts of nature acquired on works.

It is well known that Telford frequently expressed his contempt for the mere cloister engineer. On the other hand, George Stephenson has placed it on record that the great want of his life was the want of a liberal education, and that he in consequence took care that his son should have the best education to be obtained in England. We see the result of this double education in Robert Stephenson, whose name stands proudly forth among the foremost of British engineers, yet not more prominently than those of Watt, Telford, Brindley, Rennie, Chapman, Priestly, and Smeaton, self-made men; and of Isambard Kingdom Brunel, who graduated in the famous Thames Tunnel, who, had he been consigned to the charge of the college don, would have for ever lost the golden opportunity of receiving those trumpet-tongued lessons with which rebellious nature so rudely instructed him beneath the river's bed.

But we must now turn to other subjects, the works of the past year completed and in hand, projected and abandoned. Salient among them stands forth the Mont Cenis Railway. It is at last a *fait accompli*, adding additional feathers in the caps of Mr. Fell and Mr. Brunlees. It is likely to be something more than a *pis aller* to be used while the tunnel is in progress of construction, though originally intended to be that alone. The idea now prevails that many passengers will prefer a forty-eight mile ride over the Cenis Pass in a railway train, through the novel landscape features of ice and glacier, to seven and a half miles shooting through the scarp of the mountain. Certainly the tourist will prefer the former mode, though it involve the inconvenience of a change of carriages and an extra couple of hours on the route; the *habitué* of the line will prefer the straight run through. Merchandise, too, will take the shorter tunnel route.

The working parties in the tunnel are at present engaged on schist at the Italian end and limestone at the French end, driving their headings 3ft. each end per day, against 2ft. when in the compact quartz rock. How soon they may shake hands is beyond the capacity of even Mr. Brunlees to say. 1875 is now the time appointed. The shortening of the route to India by this connection of the French and Swiss railways is of much importance to this country, especially to Anglo-Indian circles. The distance from London to Alexandria *via* Marseilles, that by which a large portion of the mails and passengers is now carried, is 2,532 miles; that *via* Brindisi, the route now proposed, is 77 miles shorter in distance; and as it reduces the sea voyage nearly one-half, it offers a saving of 35 hours in time, of 39 hours *via* the Cenis Pass Railway, and of 43 hours when the new tunnel shall be completed. Such inducements as these prospects afford ought and will be shortly taken advantage of. The French who now have a monopoly of that part of the journey from Calais to Malta (if not to Alexandria), naturally object to the transfer; but the force of circumstances must ultimately prevail, and the French will at Susa hand over the traffic to the Italians, who will run it down the peninsula to the point of embarkation, Brindisi.

The Suez Canal next claims our attention. It is now plain that its completion is within the bounds of possibility, though it is hard to believe that the investing public will côntinne to patronise such a vast scheme, with such remote expectations of completion as it promises. Mr. Siccama, one of the members of this society, visited it some two years since, and has given us an account of it in a paper read last year. The pith of his remarks was this, that out of 70,000,000yds. of excavation a total of 18,000.000 had already been removed. The remainder, it will be allowed, represents many years of hard work to come; and how the scheme is to be further prosecuted, and at the same time to defray the annual charge of interests on calls, is incomprehensible.

The project for the supply of London with water is still undeveloped, and the pure streams that flow from the water-sheds of the Helvellyn or Plynlymmon mountain ranges remain unimpounded. The water-supply question is now so well understood by consumers that it is not probable they will be satisfied with anything short of the very purest water the country can supply. Mr. Bateman's scheme, and that of Messrs. Hemans and Hassard divide public attention, two or three other schemes have been proposed; but those mentioned continue to hold the chief places in popular estimation, because they go right to the main available water supply sources of the island.

Mr. Bateman's scheme is to cost for works and all accompanying expenses, but not including the purchasing of the rights of existing Water Companies, £10,850,000 for a supply of 220,000,000 of gallons per day. This, he states, can be served out to the London consumers at annual rate of 12d. in the pound of the rateable value of London property.

Messrs. Heman's and Hassard's scheme, under the same circumstances, is estimated to cost £11,200,000 for 200,000,000 gallons per day, at a rate of from 8d. to 13d. according as circumstances turn out, the last to be the rate under the worst circumstances.

From these statements, it will be seen how very closely the rival projects are weighed financially. Mr. Bateman's fountain head lies at 183 miles from London in Wales, Mr. Heman's at 240 miles in Cumberland. Mr. Bateman has the advantage as to distance and also as to prime cost; but it is questionable if this is not compensated in Mr. Heman's scheme, in passing through and alongside the east boundaries of the populous and rapidly-rising districts of Lancashire, Manchester, the Potteries, and Birmingham, which would be in time valuable customers for the surplus water of the aqueduct. I have myself visited both catchments, have drunk invigorating draughts of their waters, and peered into their natural reservoirs from the summits of Cader Idris and of Helvellyn, and can safely vouch as to their amplitude and extreme purity and limpidity. In Mr. Bateman's pamphlet will be found a pertinent statement for the consumer's eye—viz., that the present rates for water in the towns of Liverpool, Glasgow, and Manchester, are 10½d., 13d., and 12d. in the pound. The respective prime costs of their waterworks being for 1,000,000 gallons supplied per day—viz., £115,000, £60,000, and £60,000, in London, the relative charges under the new system being £100,000 and about a 12d. rate.

The Mersey and Channel Tunnels have made no advance during the past season. Mr. Remington's project for tunnelling the channel from Dungeness Point in preference to taking a more easterly line looks well. He claims for his idea the advantages of a lower landfall, a wealden clay substratum in which to drive his headings, and a bank at nearly half the space of the channel which can be made available as a Point d'Appui, as well as for a permanent shaft. His line would be slightly longer than that of the Dover project, where the land is high and the substrata chalk, being loose and water bearing. In the meantime there is a plan on foot which is likely to find supporters immediately on the return of confidence, inspired by the president of the Institute, and which will probably take the same position with regard to Mr. Remington's scheme that the summit railway of Mr. Brunlee's does to the Cenis Tunnel. It is that of a railway ferry, the boats to be 600 feet long to carry the trains bodily across. Mr. Fowler proposes to run out a pier parallel to the Admiralty Pier at Dover. Between these moles the boats will lay when receiving and discharging their trains. We are not yet informed how the difficulties arising from the rise and fall of a 22 foot tide are to be combated; on the French side the Calais pier is to be considerably extended on cast-iron screw piles. This is the most utterly unpleasant channel passage around our coasts. There is here continually a chopping sea, perfectly destructive to the comfort of all passengers but those who are born sailors. Nausea will by this plan be all but eliminated for, with such long boats in such a sea, the pitching of the vessel will be *nil* while the rolling will be reduced to a minimum.

The project for the crossing of the Mersey is even farther from a satisfactory solution than those last mentioned. Mr. Brunlee's design for a bridge at the Runcorn side of the town, as well as Mr. Fowler's tunnel, have equally fallen through. Mr. Hawkshaw has conceived a new idea here—that of a tunnel from New Brighton to Bootle, which he believes he can accomplish at a much less cost than any other scheme, as he will then find a more tractable rock than elsewhere; we may, however, prophesy that the Liverpool merchants are too good judges of the value of time to commit themselves to such an out-of-the-way route, which one of Mr. Lyster's circular ferry-boats will beat in a canter. They like to see their money's worth; they are accustomed to the stately ships. They will, with their

present æsthetic aspirations, prefer the stately bridge to a burrow under their river's bed, even though it cost something more than the latter. In ten years more we may see the enterprise floated, meanwhile they are setting themselves to improve their ferry approaches and accessories.

Mr. Hawkshaw has placed a specification of his tunnel scheme before the Corporation, who have acknowledged his receipt with thanks. More than this we do not know at present.

In marine engineering several novelties have been introduced of late, prominent among which are the *Ross Winans*, cigar ship, the *Waterwitch*, and an *enfant prodige*, hatched under the auspices of the Admiralty, of which, however, nothing has turned up, save that it is intended with a steam-engine of one-horse power to do the work of 100 horses, by so disposing and directing water pressure as developed in the hydraulic press as to produce rotary motion. Here we behold the *ignis fatuus* perpetual motion in a new dress.

Their *Waterwitch* has been a greater success, to judge from its recent trials with her sister ships, the twin screws *Viper* and *Vixen*. She has made a vast advance on previous comparisons, so far as to come within a fraction of the speed of the *Viper*, the figures being 9·28 knots for the one, against 9·70 for the other. We do not, however, in last week's trials, hear anything of improved facilities in turning, in which she was beaten hollow by the twin screw on former occasions—taking twice as long to make a complete revolution as the screws. It was in the matter of rapidity of evolution her strength was at first supposed to lie, by the sudden change of one or both ejecting nozzles from an after to a forward direction, or *vice versa*, for which her peculiar machinery gave great facilities. After the *exposé* at her former trials, we cannot look for much improvement in this direction. She has, however, made a remarkable advance in speed; and it is to be hoped, for the sake of her crafty designer, that further efforts shall further improve her very novel powers. If her propelling machinery be of like weight to that in the sister and twin screw ships, she must labour under a great disadvantage in comparison with them, seeing that she carries a surplus in the volume of water absorbed by her central wheel, its avenues, and nozzles.

Gunnery engineering has during the past season received, if possible, more than the usual attention. The chief events of the period, as far as they can be collected from the published accounts, which must not in all cases be taken as genuine, have been the piercing of the Hercules target with Palliser's chilled shot, both rectangularly and in an oblique direction. This science cannot be said to have arrived at a stage level with the national desires, until we shall have produced a gun capable of penetrating a 10-inch plate, with a 600lb. shot, with entire safety to the gunners engaged.

The Rodman cast-iron gun, lately bought from the Americans, has been tried within the past month at Shoebury. With it, the Hercules target has been pierced at 70 yards, square, with a charge of 100lbs. powder, 60lbs. being its safe charge; and that which Admiral Farragut stated, during his late visit, should be held its maximum charge. It is doubtful if the same result would obtain at 200 yards' distance, considering the rapidly-diminishing initial velocity of its spherical projectile. The authorities are desirous of testing its powers with normal charges before they again subject it to the crucial test of burning near one cwt. of powder. The English 12½-ton, wrought iron built-up gun has with its bolt produced the same result easily at 200 yards. Our superiority so far then is apparent, when with a 12½-ton gun we can produce the same results as the American 23-ton gun, and that at 200 yards as against 70 yards. Our 600 pounder 20-ton gun has yet to be tested. One of this pattern is at present placed in position on the glacis of Southsea Fort, Portsmouth. We will anxiously look for the results of experiments shortly to be made on it. We do not seem to be clearly informed as to what results have been obtained with shell. This is the prince of projectiles. Has Major Palliser succeeded yet in getting it through the Hercules plates?

The masonry of the Royal Engineers' work called the Land Fort—one of the new defences of the Medway—has sunk bodily into the ground, after having been carried to a height of eight feet above the surface level. This is an event hardly credible in the face of the well-known scientific attainments of the distinguished body of men who are accountable for the result. All are aware that cloister education has never before been carried to so high a pitch in that corps. Can it be that, in their enthusiasm for the theoretical, they have lost sight of the practical, and become disciples of Berkley's theory?

But railways now claim our attention. In this ever productive source of occupation for the engineer there is complete stagnation. During last session the panic had reached its climax, and the half-dozen lines of consequence promoted were allowed to drop. The business of the session was accordingly confined to loops, spurs, deviations, and insignificant extensions. The great bill of the session, that promoted by the London and North-Western Railway Company to connect its system with the important town of Sheffield, entitled the Buxton, Chapel-en-le-Frith, and Sheffield Railway, after having been carried successfully through the ordeals of standing orders, Referee's Court, and Committee of the House of Commons, was withdrawn, running powers having been granted to the London and North-Western Railway Company by the Manchester, Sheffield, and Lincolnshire Company. The other great railway bill of the session, promoted by the Midland Railway Company, for amalgamation with the Glasgow and South-Western Railway of Scotland, was stoutly opposed through its whole course with varying success by the London and North-Western Railway Company, ending, however, in the thorough defeat of the promoters before the Lords' Committee. The promotion of such a bill was a mistake from the outstart, seeing that the Midland Company are even at this hour 74 miles distant from the gaol of their desires—Carlisle. This gap will, no doubt, be shortly bridged, their line from Settle to Carlisle having been authorised by Parliament in the session of 1865-66.

Turkey is a country in which there is much to be done, and, if we are correctly informed by the press, the Sultan is now engaged in preparing extensive schemes for the introduction of railways.

In Russia also there is expectation of railway work in prospect. Berths in either of these countries should be narrowly watched. Russia pays capable men better than any country in Europe.

China and Japan are still without railways, and will, doubtless, ere long call for their introduction. Japan has already given orders in England for guns and ships; the railway, sooner or later must follow.

The most novel feature in railway works in London is the advance of a leg of the Midland system as far as Saint Pancras, which here takes up its habitation in a first-class metropolitan station. We cannot help admiring the successful strides and dash of this spirited company, formerly confined to a few central shires, and now ubiquitous, while, at the same time, we express our surprise to see it settling so grandly in a position which, to all appearances, must, ere long, become only an intermediate station. The march of events points to sites on either the line of the Strand, or on that of the New Embankment on the north bank of the Thames, lying between Trafalgar-square and Temple Bar, as the ultimate destination of our great lines of railway trending from the North and West.

The latter causeway will furnish the finest and most convenient sites in London for railway stations and hotels of the mammoth dimensions now required. The public are hardly yet aware of the great boon they will receive in the opening of this line of route, and with the object in view of fringing it with palatial buildings, they should insist on having a causeway of 150ft. wide throughout, where possible; the paltry 80 offered by the Metropolitan Board of Works should not be tolerated, seeing that a large space has been reclaimed from the river. Such a thoroughfare, extending from the Victoria Tower, Westminster, to the Tower of London—a crystal Thames on the one hand, spanned by troops of exquisite bridges and a row of palaces on the other—would present a *coup d'œil* unequalled in the great cities of the world.

The works of the East London Railway were visited this year by this society, with the permission of the engineer. The object of this company is to connect the railway systems of East London, lying north and south of the Thames, through the line of the Thames Tunnel. It is an excellent conception, and will, we must expect, be a connecting link of great importance in the thickly inhabited districts it proposes to occupy.

The Willesden Junction Station of the London and North-Western Company approaches completion—also visited by this society. Here are platforms of over one mile in length, sidings of seven miles, two railway bridges and one turnpike road bridge right over the station, together with the Midland and South-Western Junction railway bridge a few hundred yards to the north-west, forming a range of delightful complexity to the eye of the citizen experienced in the intricacies of the London system of railways, connected as it is in his mind with conveniences for locomotion surpassing even his exacting expectations. This junction is a Clapham built up at the first intention, and furnished with all the newest inventions and appliances. It cannot fail to be largely patronised by the public as soon as it is finished and becomes generally known; and to bring additional lustre to the officers of the great company who have so successfully and thoughtfully conceived and executed it. The traffic collected in the ramifications of 1,333 miles of railway at present belonging to the London and North-Western Railway Company requires the fullest development of such exchange stations as this. They are the valves and ports of the great iron arteries through which the life of England circulates.

Perhaps the question of greatest interest to the engineer, in the matter of construction of the season, is that of Bessemer iron. While so much is known theoretically of its structure and properties, it must be said that practically we are still in the dark about it. This is the more strange, as thousands of tons of the precious metal are being produced daily; in fact the present production of Bessemer iron in all countries is 500,000 tons annually, England making twice as much as the rest of the world put together. One of our members, it will be remembered, Mr. Black, read a paper on the subject lately, illustrating it by various curious and interest-

ing specimens in angle iron and rods. A common idea expressed on that occasion was, that a metal capable of such a variety of expression must be thoroughly understood before being adopted in difficult engineering works. Some of his specimens shown were so knotted and contorted, and that done when in the cold state, that the question was at once asked, can such a metal be safe for the compression chord of a girder? Certainly, was the reply, not of that precise degree of softness and ductility; we can make it of any degree of stiffness required. Here it appears is just the difficulty. The metal can be produced in so many different degrees of hardness between that of extreme pliancy and of extreme shortness, that the engineer who wants 500 tons of it for a long span girder is not sure that he will be supplied with the mass of a perfectly even and equable quality. It will take some years of groping in the dark before the riddle is solved.

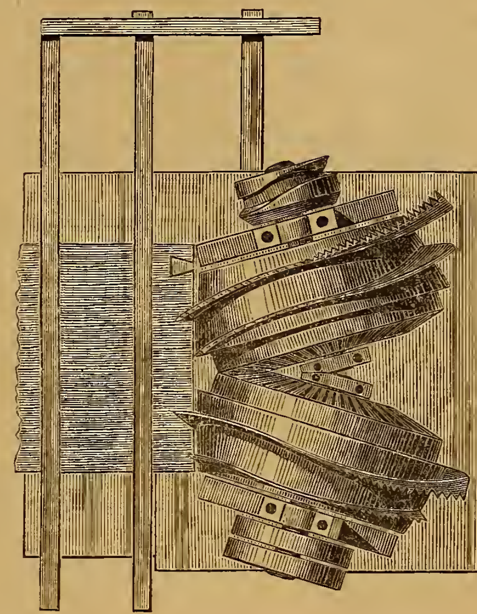
The Thames Embankment and the Sewage Works have been visited by this society. These two vast undertakings are rapidly pushing on to completion, and are subjects of surpassing interest to the engineer. There are three sewers on each side of the river at different levels, and parallel to each other, viz.:—the high, low, and middle level sewers. The great object was of course the removal of a maximum of the sewage by gravitation. On the north side, the three sewers unite at the Abbey Mills pumping station; the two high level sewers passing through to the north outfall at Barking, the low level sewer being pumped into their level.

The three south sewers unite at Deptford, and flow through the south outfall at Crossness in Erith Marshes, the low level being pumped into the upper levels at the first-named place. At Crossness outfall all three can be discharged at low water if necessary, but will ordinarily be pumped up and discharged at high water. As a rule, all the sewage will be discharged into the river on the top of the tide, so that the ebb will carry it away seawards. The total cost of these works will be £4,100,000. The engine power at Abbey Mills, for a lift of 36ft., is 1,140 horses; at Deptford, 500 horses for an 18ft. lift; at Crossness, 500 horses for a 10ft. to 30ft. lift.

The Crossness engines and works have been completed long since. The northern high and mid level sewers are completed and working. The low level is not yet finished, neither are the engines, as was seen during our visit to Abbey Mills on the 5th instant. After having so successfully completed such a gigantic series of works as this, Mr. Bazalgette may be truly said to be the first sewage engineer in England. He has been lately called on to report on a scheme for the sewage of the city of Glasgow. The usage in the two cities is dissimilar. In London we rectify our sewage first, and then provide a water supply; in Glasgow they first provide water, and afterwards look to means to carry it away. Theoretically, London is right; practically, Glasgow will be ahead of us: for she will have constructed both water and sewage works, when we shall have sewage alone.

AMERICAN DOVETAILING MACHINE.

One of the last additions to the Paris Exhibition, which is now a thing of the past, was a very ingenious dovetailing machine in the American department. The machine was mounted on a neat rectangular frame, carried on four cast iron standards, having at its further extremity brackets carrying the main or driving shaft, and the discs which carry the helical saws, and on its front side guides for the movable table which carries the piece of wood to be dovetailed. This table is moved longitudinally by means of a screw about 1in. pitch, having one of its sides conical to increase the bearing, working into a segment of a nut on the underside of the table. By means of a handle conveniently placed at the side of the table, this segmental nut can be thrown in and out of gear; but, in addition, there is a screw with about 1-16th inch pitch, working in the under part of the table, and giving every facility for the accurate adjustment of the piece of wood to be operated upon after the segmental nut has been put in gear with the main screw. The motion for the screw is derived from the main shaft by means of a pinion driving a wheel loose on its axis, and so arranged as to communicate the necessary speed to a pinion on the screw shaft. The main shaft has on it a fast and loose pulley, the pinion above mentioned, and a bevil wheel driving another loose on its spindle, thereby communicating motion to a bevil wheel on the outside of one of the discs carrying the saws. There are two discs mounted on axes inclined to each other, as well as to the main driving shaft, and revolving at the same speed, the one being inclined to the right and the other to the left, the motion being transmitted from the first to the second disc by means of bevil wheels cast on their inner surfaces. Each disc has on its outer circumference a spiral groove making one complete turn, into which is fitted a saw composed of segments, so arranged as in one complete revolution to give both the longitudinal and transverse cut necessary to finish a dovetail, one half being made by one disc and the other half by the other. The leading portion of the saw is composed of segments similar to those that could be cut from an ordinary fine pitched circular saw, whilst to produce the transverse cut after the longitudinal one is finished, the segments assume the form shown in the accompanying engraving, from an inspection of which the arrangement will be readily understood.



These segments are held in their place by means of cast iron cheek plates, held on by set screws with square heads, and in about one minute the attendant on the machine could change all the segments, and replace them by others having a finer or coarser pitch of teeth, if desired. To prevent the saws from splintering the wood on its under side, a longitudinal shallow cut is made by a knife edge at the bottom of the dovetail before the helical saws operate on the wood; this is a most important point, and without it good work cannot be produced. At the back of the machine a small horizontal shaft carries two pinions, which gear into quadrantal wheels fixed on the main spindle, which cause the bearings of the discs to revolve, and so, consequently, the discs with their saws revolve through a quadrant, giving the facility for cutting the counterpart to the dovetail. An arrangement is also provided for raising the table so that the dovetailing can be done on the bevil, if required. The attendant all day long was besieged by crowds anxious to see this machine at work, and certainly he showed great patience in altering his machine to convince the sceptical of its wonderful scope and accuracy. The machine is patented by Mr. Armstrong, of New York, and already the English patent has been sold to Messrs. Robinson and Son, of Rochdale, near Manchester, the French one to Messrs. Martin, Son, and Co., of Rouen, and the German one to Messrs. Richard Hartmann and Co., of Chemnitz, Saxony.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

The last Ordinary Monthly Meeting of the Executive Committee of this Association was held at the offices, 41, Corporation-street, Manchester, on Tuesday, October 29th, 1867, when Mr. L. E. Fletcher, chief engineer, presented his report, of which the following is an abstract, as well as of the working of the previous month, the particulars of which have not as yet been preseuted to the members:

"During the last two months 481 visits of inspection have been made, and 1,100 boilers examined, 777 externally, 26 internally, 15 in the flues, and 282 entirely, while in addition 10 have been tested by hydraulic pressure. In these boilers 318 defects have been discovered, 15 of them being dangerous.

"Tabular Statement of Defects, Omissions, &c., met with in the Boilers examined from Aug. 24th to Oct. 25th, 1867, inclusive.

Description.	Number of Cases met with. Dangerous.	Ordinary.	Total.
Defects in Boiler.			
Furnaces out of Shape	2	12	17
Fracture	3	22	25
Blistered Plates	...	14	14
Corrosion—Internal	2	37	39
Ditto External	3	31	34
Grooving—Internal	...	16	16
Ditto External	...	8	8
Total Number of Defects in Boilers ...	10	143	153
Defective Fittings.			
Feed Apparatus out of order	1	...	1
Water Gauges ditto	1	24	25
Blow-out Apparatus ditto	2	15	17
Fusible Plugs ditto	...	...	...
Safety Valves ditto	...	16	16
Pressure Gauges ditto	...	28	28
Total Number of Defective Fittings ...	4	83	87
Omissions.			
Boilers without Glass Water Gauges	...	20	20
Ditto Safety Valves	...	...	...
Ditto Pressure Gauges	...	2	2
Ditto Blow-out Apparatus	...	19	19
Ditto Feed back pressure valves	...	33	33
Total Number of Omissions	...	74	74
Cases of Over Pressure	...	1	1
Cases of Deficiency of Water	1	2	3
Gross Total	15	303	318

"Details may be given of two or three of the defects enumerated in the preceding table, which were met with in making internal and flue examinations of the boilers.

"Internal Corrosion.—On our Inspector's getting inside a double-flued boiler, and sounding it with a hammer, the rivet heads proved to be so rotten that 30 or 49 of them flew off. Corrosive water has a very treacherous effect upon rivet heads and the overlap of the plates, since in many cases, though the nature of the metal is so destroyed that they are completely rotten, the danger would pass undetected unless they were tested with a blow.

"External Corrosion.—Two cases in which boilers have been met with in dangerous condition from external corrosion, have resulted from setting boilers on midfeathers.

"One boiler was just enrolled with this Association, and on examination being made, the plates resting on the midfeather, which was 18ins. wide, were found to be dangerously corroded from one end of the boiler to the other, while the seating was covered with oxide upwards of an inch thick. The external flues were excessively damp, and the boiler, which had just changed hands, had been lying at rest for some time, and though the plates were completely rotten, it was with great difficulty that the owner was persuaded that the boiler was unfit for immediate use. Had steam been got up but one result must have followed, and the owner has to thank the Association for saving him from an explosion, though rather against his will.

"In a second case the brickwork of the external flues was perfectly dry, and the plates on each side of the midfeather exhibited no signs of corrosion, yet it was recommended that pockets or sight holes should be ploughed out at the transverse seams in order that the condition of the plates might be seen. On this being done it was found that at three of the seams the plates were so severely eaten away by corrosion consequent on leakage, that the safety of the boiler was seriously endangered, which shows the importance of having these sight holes ploughed out in the midfeather walls at the transverse seams in every instance, though the flues may be dry and the plates on each side of the midfeather unaffected.

"In a third case a double furnace boiler, though set on side walls, was found to be corroded from one side to the other where it rested on the brickwork, owing to the injudicious manner in which the boiler was set, being let down on to the solid brickwork with seatings 18ins. wide, instead of being carried on suitable firebrick blocks. These blocks raise the boiler above the bottom of the side flues, thus rendering the plates less accessible to damp, and at the same time affording a chamber for the lodgment of the soot instead of allowing it to lie in contact with the plates; while in addition, since the width of the bearing surface need not exceed 5ins., there is less surface to harbour corrosion should any moisture lodge between the seating blocks and the plates. The importance of introducing these firebrick blocks has already been pointed out on several previous occasions.* This boiler was also found to be seriously attacked by internal corrosion; the water with which it was fed being drawn from the coalpit at which the boiler worked, and no treatment having been adopted to modify its corrosive tendency.

"Explosions.

"On the present occasion I have five explosions to report, which have resulted in the death of seven persons, as well as in serious injury to six others. Not one of the boilers was under the inspection of this Association.

"Tabular Statement of Explosions, from August 24th, 1867, to October 25th, 1867, inclusive.

Progressive Number for 1867.	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
18	Aug. 27	Ordinary Single-flue, or Cornish. Internally-fired	6	4	10
19	Sept. 2	Locomotive	0	0	0
20	Sept. 9	Ordinary Double-flue, or Lancashire. Internally-fired	0	1	1
21	Oct. 4	Water Heater	0	1	1
22	Oct. 7	Ordinary Single-flue, or Cornish. Internally-fired	1	0	1
		Total	7	6	13

"No. 18 Explosion was very disastrous, resulting in the death of six persons, as well as in injury to four others. It occurred at about ten o'clock on the morning of Tuesday, August 27th, at a flax mill. The boiler was internally-fired, and of the ordinary Cornish construction, while its length was 18ft., its diameter in the shell 4ft. 9ins., and in the furnace tube 1ft. 6ins., the plates in the shell, flue, and ends being three-eighths of an inch thick.

"The boiler was warranted by the makers to be perfectly safe at a pressure of 100lb. per square inch, and had only been at work about a fortnight. It had leaked, however, at the back end plate soon after it was set to work, and on the morning of the explosion the owner went on the top of the boiler, and assisted by another man, attempted to cure the leak, either by caulking it or dressing the defective part with a cold chisel, the steam at the time being up to a pressure of 50lb. on the square inch. After they had been striking the boiler for some little time, the back end plate suddenly blew out, when the owner and his companion were both hurled to a considerable height, one being thrown across a shed and wide stream add the other over the mill, while in addition three men in the engine-room were killed on the spot, a lad blown to a distance and dashed against a wall, the boiler torn from its seat, the engine house thrown down, the mill set on fire and burnt to the ground.

"The cause of this explosion, though so disastrous, is very simple. The boiler was badly made, the angle iron attaching the back end plate to the shell being in two pieces, jump jointed, instead of in a solid welded ring throughout, while the ends were altogether unstayed, whereas there should have been some substantial gussets. The joints in the angle iron rings were placed one at the top and the other at the bottom of the boiler, and it was at the joint on the top of the boiler, at which continued leakage had taken place, and which the owner of the boiler was attempting to correct as just mentioned, that the rupture com-

* See Association's Printed Monthly Reports, No. 20, August, 1863, and No. 52, April, 1866, No. 16 Explosion.

menced, which extended through the line of rivets throughout the entire circumference of the back end plate. Had the end plates been strengthened with gusset stays, even though a rupture had been started, it would have been kept from spreading and rendered comparatively harmless. The maker of this boiler, who warranted it as safe at a pressure of 100lb., must have been sadly ignorant of the strength of materials, or the power of steam, and the explosion is attributed to the mal-construction of the boiler.

"At the same time, however, this opportunity may be taken of pointing out the danger of caulking boilers with steam up, and our members may be reminded of the explosion that occurred to a locomotive boiler in this city about nine years ago, killing five or six persons, just as the seams were being caulked; while it may be mentioned that another explosion happened under similar circumstances on the 14th January, 1865, killing three persons and injuring six others, so that caulking the seams of boilers with steam up should never be practised.

"No. 22 Explosion occurred at half-past six o'clock on the morning of Monday, October 7th, at a railway coal depôt, and resulted in the death of one person. It appears that at this station the roadway is about 20ft. above the level of the railway, and that the coal trucks are raised from the rail to the road by means of a hoist driven by steam power. It was on this service that the boiler in question was engaged, and it exploded in the act of hoisting a truck, just when it had raised it about 2ft. from the ground.

"The boiler was of plain Cornish construction, having a single flue tube running through it from one end to the other, and being fired internally. Its length was 12ft., its diameter in the shell 4ft., and in the flue 2ft. 2ins., while the thickness of the plates was seven-sixteenths of an inch in the shell, three-eighths in the flue, and half an inch in the ends, the ordinary pressure being about 50lb. on the square inch.

"The boiler rent in the external shell, one portion of which was thrown on to the line, and the other up into the framing of the coal-lift, where it remained suspended, while the flue tube with the plates was thrown across the railway, and over a two-storied house to a distance of about 100 yds., in addition to which the engine house was blown to pieces, the *débris* scattered in every direction, and the fireman killed.

"The cause of the explosion was external corrosion, by which the boiler was attacked at the bottom of the shell, where it rested on a midfeather wall of the excessive width of 2ft. 6in., at which part the plating about midway from each end had become reduced from the original thickness of seven-sixteenths of an inch to that of one-sixteenth, while rupture was accelerated by the engineman's being in the habit of placing a brick upon the safety-valve lever to increase the pressure when he had a heavy truck to hoist. This explosion affords an additional illustration of the importance of competent periodical inspection, as well as of the danger of setting boilers on wide midfeather walls, and the necessity of sight holes or pockets for ascertaining the condition of the plates, explained in the Association's Monthly Report for July, 1867, while it shows the importance of furnishing boilers with duplicate safety-valves of the dead weight class, which cannot be so readily overloaded as those constructed with levers.

"L. E. FLETCHER, Chief Engineer."

NOTICES TO CORRESPONDENTS.

A Ten Years' Subscriber.—1. We know of none other but Sir W. Armstrong, the patentee. 2. The best journal we know of the kind you mention is "Annales du Génie Civil," edited by Eug. Lacroix, 15, Quai Malaquais, Paris.

NOTES AND NOVELTIES.

MISCELLANEOUS.

All trace of the French Exhibition is not to close with the end of the show. The reserved garden is to escape. The plants belonging to exhibitors, which are now being removed, will be immediately replaced by the horticultural treasures of the city of Paris. The great salt water aquarium has been replenished, and turbot, lobster, eels, plaice, &c., may now be seen disporting themselves.

A correspondent of the *Builder* writes: "Determined to see for myself what has been accomplished with concrete, I visited the concrete houses at Gravesend, and, fortunately for my conviction, I arrived at the time of the examination by the Committee of the Metropolitan Board. I saw a 9in. concrete wall battered with a 14lbs. sledge hammer. Mr. Vulliamy, the architect of the Board, said that, with about three such blows, a hole would have been made in a 14in. brick wall. I cannot say what number of blows were inflicted, but certainly the wall was struck vigorously, the only perceptible effect being a slight crushing of the stones on the surface of the concrete on the side hammered. Mr. Vulliamy tested the wall on the other side with a straight-edge, and declared that not the slightest effect was produced."

TELEGRAPHIC ENGINEERING.

The submarine telegraph between Dover and Boulogne was broken on the 20th ult., at a spot three miles and a half from the French coast, but has since been successfully repaired.

The project for placing telegraphs throughout Great Britain and Ireland, under the management of the Post Office department, has been under the consideration of ministers of different Governments for the last three years, and now a bill has been drawn up, which will be introduced into Parliament with all convenient speed, for the purpose of accomplishing this much-needed reform in our telegraphic communication.

A memorial in favour of a Government guarantee of 5 per cent. on a capital of £1,000,000, to enable the proposed Anglo-Indian Telegraph Company to establish an independent line to India, has been signed by the leading houses connected with our Eastern trade, and transmitted to Sir S. Northcote by the Lord Mayor.

LATEST PRICES IN THE LONDON METAL MARKET.

	From £	s.	d.	To £	s.	d.
COPPER.						
Best selected, per ton	77	0	0	78	0	0
Tough cake and tile do.	76	0	0	77	0	0
Sheathing and sheets do.	80	0	0	,,	,,	,,
Bolts do.	83	0	0	,,	,,	,,
Bottoms do.	85	0	0	,,	,,	,,
Old (exchange) do.	70	0	0	71	0	0
Burra Burra do.	84	0	0	85	0	0
Wire, per lb.	0	1	0	,,	1	0½
Tubes do.	0	0	11½	0	1	0
BRASS.						
Sheets, per lb.	0	0	9	0	0	10
Wire do.	0	0	8½	0	0	9½
Tubes do.	0	0	10½	,,	,,	11
Yellow metal sheath do.	0	0	7¼	0	0	,,
Sheets do.	0	0	7	,,	,,	,,
SPELTER.						
Foreign on the spot, per ton	21	15	0	,,	,,	,,
Do. to arrive	21	15	0	,,	,,	,,
ZINC.						
In sheets, per ton	28	0	0	,,	,,	,,
TIN.						
English blocks, per ton	96	0	0	,,	,,	,,
Do. bars (in barrels) do.	97	0	0	,,	,,	,,
Do. refined do.	99	0	0	,,	,,	,,
Banca do.	92	10	0	,,	,,	,,
Straits do.	89	10	0	90	0	0
TIN PLATES.*						
IC. charcoal, 1st quality, per box	1	7	6	1	9	6
IX. do. 1st quality do.	1	13	6	1	15	6
IC. do. 2nd quality do.	1	5	6	1	7	6
IX. do. 2nd quality do.	1	11	6	1	13	6
IC. Coke do.	1	2	6	1	4	6
IX. do. do	1	8	6	1	10	6
Canada plates, per ton	13	10	0	,,	,,	,,
Do. at works do.	12	10	0	,,	,,	,,
IRON.						
Bars, Welsh, in London, per ton	6	10	0	,,	,,	,,
Do. to arrive do.	6	10	0	,,	,,	,,
Nail rods do.	7	0	0	7	10	0
Stafford in London do.	7	10	0	8	10	0
Bars do. do.	7	10	0	9	10	0
Hoops do. do.	8	10	0	9	12	6
Sheets, single, do.	9	5	0	10	0	0
Pig No. 1 in Wales do.	3	15	0	4	5	0
Refined metal do.	4	0	0	5	0	0
Bars, common, do.	5	15	0	6	0	0
Do. mrch. Tyne or Tees do.	6	10	0	,,	,,	,,
Do. railway, in Wales, do.	5	0	0	5	10	0
Do. Swedish in London do.	10	2	6	10	5	0
To arrive do.	10	2	6	10	5	0
Pig No. 1 in Clyde do.	2	14	6	3	1	0
Do. f.o.b. Tyne or Tees do.	2	9	6	,,	,,	,,
Do. No. 3 and 4 f.o.b. do.	2	6	6	2	7	0
Railway chairs do.	5	10	0	5	15	0
Do. spikes do.	11	0	0	12	0	0
Indian charcoal pig in London do.	7	0	0	7	10	0
STEEL.						
Swedish in kegs (rolled), per ton	14	5	0	,,	,,	,,
Do. (hammered) do.	15	10	0	15	15	0
Do. in faggots do.	16	0	0	,,	,,	,,
English spring do.	17	0	0	23	0	0
Quicksilver, per bottle	6	17	0	,,	,,	,,
LEAD.						
English pig, common, per ton	19	5	0	19	10	0
Ditto. L.B. do.	19	15	0	,,	,,	,,
Do. W.B. do.	21	15	0	,,	,,	,,
Do., ordinary soft, do.†	20	0	0	,,	,,	,,
Do. sheet, do.	20	10	0	20	15	0
Do. red lead do.	20	15	0	21	5	0
Do. white do.	27	0	0	30	0	0
Do. patent shot do.	22	0	0	23	0	0
Spanish do.	19	10	0	,,	,,	,,

* At the works 1s. to 1s. 6d. per box less.

† A Derbyshire quotation, not generall known in the London market.

LIST OF APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF "THE ARTIZAN."

DATED OCTOBER 17th, 1867.

2905 D. Pidgeon and W. Manwaring—Reaping and mowing machines
2906 J. Oxley and G. Wilson—Cleansing casks
2907 W. B. Adams—Locomotive engines, &c.
2908 M. Wilkin and J. Clark—Mode of signalling upon railways
2909 W. R. Lake—Electric telegraphic apparatus
2910 E. Shaw—Coverings for vehicles
2911 R. C. Ross—Mechanism employed for cutting materials
2912 J. Rives—Casting metals, &c.
2913 C. S. Lynch—Improvements in governors for engines
2914 L. Hamel—Clipping fabrics
2915 O. C. White—Chairs for the use of dentists, barbers, photographers, &c.
2916 T. Bell and J. Richardson—Hulling grain
2917 G. M. Wells—Boots and shoes
2918 J. Bonehr—Supplying deodorising matter to earth closets
2919 J. Cubitt—Preservation of substances from decay, &c.
2920 W. Tredgold and J. McNeil—Steam boilers and furnaces

DATED OCTOBER 18th, 1867

2921 J. Hale—An entwining pocket gaiter
2922 F. Pridmore, F. Cooper, and J. F. Cottrell—Stoppers for bottles
2923 H. W. Garnett and G. Holcroft—Firearms and ordnance and cartridges for the same
2924 H. Sharp and F. W. Webb—Smiths' anvils
2925 R. Casper—Preventing the bursting of the tubes in steam and other pipes from the effects of cold
2926 J. Hill and S. Shelley—Preparing weft
2927 E. T. Hughes—Hats and bonnets
2928 W. H. Tasker—Shuttle eye
2929 J. Sexton and H. Smith—Steam boilers
2930 T. Kitchen—Grinding grain
2931 H. J. Bure—Cooking by means of gas
2932 T. Whitehead—Roving and spinning fibrous substances
2933 S. S. Maurice—Improved fastening
2934 J. King—Hoists or lifting machines
2935 J. J. Holden—Cleaning boots, &c.
2936 C. Marugen—Articles of apparel worn on the head by women and children
2937 M. Alex—Davits for vessels

DATED OCTOBER 19th, 1867.

2938 F. W. Waide—Internal decorations of dwelling houses, &c.
2939 M. J. Matthews—Pianofortes
2940 W. Liebermann—Construction of churns
2941 W. R. Lake—Breech loading firearms
2942 A. F. Jaloreau and C. L. Lardy—Telegraphic cables
2943 L. Newton and J. Swailes—Corks for bottles
2944 J. Schwartz—Cooling water
2945 F. Adkins—Manufacture of hoes
2946 J. Anderson—Fens, &c.
2947 E. Butterworth—Preparing and spinning fibrous substances
2948 M. W. Shove—Construction of letter boxes
2949 R. Watkins—Discharging projectiles under water
2950 H. Hughes—Ornaments

DATED OCTOBER 21st, 1867.

2951 M. B. Nairn—Power looms
2952 W. Crossley and T. C. Hutchinson—Manufacture of alumina, &c.
2953 W. Barrett and C. Martin—Tuyeres
2954 C. D. Abel—Screw bolts and nuts
2955 J. Hunter—Permanent way of and in signalling on railways
2956 J. Clapier—An hygienic pillow
2957 A. H. Brandon—An articulated artificial leg
2958 C. Dunconibe—Charging and closing breech loading cartridge cases
2959 H. Hughes—Bottles and other receptacles
2960 W. R. Lake—Electric telegraph apparatus

DATED OCTOBER 22nd, 1867.

2961 J. Adams—Construction of breech loading revolver firearms
2962 T. Webb—Sewing machines
2963 C. Ritchie—Tobacco pipes
2964 T. Lemettle—Fans for the ventilation of mines
2965 P. Walker and A. Walker—Shoes for animals
2966 N. A. Thommelet—Producing from one piece of writing paper a sheet of note or letter paper and an envelope to enclose the said sheet of paper
2967 G. Jones—Mounting wheels to road carriages of all kinds
2968 J. White—Means for ventilating
2969 W. Beale—Telescopic apparatus
2970 H. W. Sambridge—Pendent lamps
2971 A. V. Newton—Dredging and spice boxes
2972 W. Gray—File blanks
2973 W. Brookes—Treating hides

DATED OCTOBER 23rd, 1867.

2974 J. Haddock—Shuttle tongues
2975 C. D. Abel—Pulverising substances
2976 T. Welton—Oxygenated substances
2977 F. J. Bugg—Pressed leather
2978 F. Seiler—Compressing air, &c.
2979 G. S. Jeaffreson—Treating fractures of the limbs
2980 A. M. Clark—Steam governors and valves
2981 J. L. Norton—Forming wells

DATED OCTOBER 24th, 1867.

2982 A. Chambers—Manufacture of files
2983 H. R. St. Martin—Ornamenting glass
2984 F. Gerhartz—Manufacture of manures and disinfectants
2985 J. Thom and A. MacLure—Manufacture of ornamental fabrics
2986 R. W. Thomson—Wheel for steam carriages
2987 J. Ellison and J. Stirk—Economising fuel and consuming smoke
2988 W. E. Gedge—A novel kind of nail
2989 G. Olney—Improved illuminating gas
2990 J. Dodge—Cutting files
2991 H. Adcock—Improvements in kilns
2992 J. Mitchell—Buffers and draw springs for railway carriages
2993 H. Ritchie—Carriages
2994 S. Stockwood—Boiling apparatus
2995 A. M. Clark—Transmitting and multiplying motive power
2996 J. S. Johnson—Spinning machinery
2997 C. W. Harrison—Preventing incrustation in vessels in which water is heated
2998 R. Weare—Treatment and reception of urine and fæcal matter
2999 E. M. Palliser—Magazines for containing explosive compounds, and gunpowder

DATED OCTOBER 25th, 1867.

3000 W. Fisken and D. Fisken—Construction of boilers
3001 G. Russo and C. A. Maccaroni—Saving lives and property in case of shipwreck at sea
3002 L. Stockman—Rollers for window blinds
3003 G. J. Gunther—Protecting ships of war, &c.
3004 H. Wilson—Valves for discharging fluids or gases
3005 W. R. Lake—Carpet linings
3006 W. R. Lake—Curing, drying, preserving, and packing perishable substances
3007 T. Stennett—Dressing and other bags
3008 A. M. Clark—Mode of obtaining publicity and affording information or amusement
3009 A. M. Clark—Postage stamps, &c.
3010 P. Love—Regulating the supply of food to animals
3011 B. Cooper—Removing knots, &c., from fabrics

DATED OCTOBER 26th, 1867.

3012 J. A. Hopkinson and J. Hopkinson—Steam engine indicators
3013 R. Carter—Looms for weaving
3014 G. Dorsett, R. Dorsett, and J. Blythe—Burning the gases arising from the distillation of liquid hydrocarbons, &c.
3015 W. E. Wiley—Holders for marking materials
3016 R. M. Leirnford—Manufacture of matches
3017 W. R. Lake—An improved level
3018 L. Newton and T. Kershaw—Bottles, &c.
3019 F. M. Smith—Armour plates
3020 J. J. Terry—Binding books, &c.
3021 J. Brooks—Obtaining motive power
3022 C. E. Hall—Reaping and mowing machinery
3023 W. Kendal—Locomotive engines
3024 J. Asser—Croquet mallets
3025 A. M. Clarke—Steam generators
3026 A. M. Clarke—Railway and other brakes

DATED OCTOBER 28th, 1867.

3027 W. Payne and A. B. Fraser—Ships' and other pumps
3028 J. de Silva—Composition for coating the bottoms of ships, &c.
3029 G. Smith—Marking boards used in the game of billiards
3030 H. A. Bonneville—Manufacturing paper sacks
3031 W. E. de Bourrou—Evaporators for concentrating saccharine fluids
3032 J. Young—Application of cannel coal slack to the manufacture of gas and coke
3033 C. E. Brooman—Manufacture of lace
3034 A. J. Waterlow, W. B. Waterlow, and S. H. Waterlow—Machines for printing from metal plates
3035 J. Glover—Furnaces
3036 M. Henry—Balloons
3037 T. Bennett—Spoons, forks, and ladles
3038 W. Potts—Making moulds for screws
3039 H. G. P. Meade—Firearms, &c.
3040 V. Vicomte de Crealles—Obtaining power from streams of water
3041 W. R. Lake—Centrifugal machines for separating liquid from solid matter

DATED OCTOBER 29th, 1867.

3042 E. B. Wilson—Furnaces
3043 G. W. B. Edwards—Dibbling and dropping seed and corn
3044 J. Smyth and S. Kirby—Keyed wind musical instruments
3045 E. T. Hughes—Twisting lines, &c.
3046 J. T. Cortet—Circular webbing
3047 W. Bishop and B. Burningham—Preventing effluvia entering tanks from the waste pipe
3048 J. H. Johnson—Cleaning cotton and cotton seeds
3049 W. P. Savage—Excavating, raising, and depositing soil
3050 L. Perkins—Water and other meters

DATED OCTOBER 30th, 1867.

3051 G. Davies—Preventing incrustation in and removing it from steam boilers
3052 W. H. A. Bowley—Horse ploughs
3053 J. Leather—Cap frames
3054 J. Maddocks—Securing nuts and bolts
3055 J. R. Fenby—Improvements in valves
3056 T. E. Symonds—Ships and other vessels
3057 F. Pierce—Colouring photographs, &c.
3058 J. H. Johnson—Holders for whips, &c.
3059 James Earl of Caithness—Cleaning boiler tubes
3060 A. V. Newton—Ventilation of buildings

DATED OCTOBER 31st, 1867.

3061 C. Jobson and J. Jobson—Screw propellers
3062 R. Clegg—Construction of pumps
3063 W. Hall, J. Wren, and J. Brandwood—Producing toothed wheels
3064 W. S. Dixon—Producing a blue dye
3065 R. Donner—Cleaning skins
3066 J. P. Gard and S. Robertson—Transmitting motive power
3067 O. C. Evans—Digging machinery
3068 W. R. Lake—Cap or furniture springs
3069 W. R. Lake—Exhausting the air in vessels
3070 J. Kendrick—Steam boilers
3071 J. Walker—Axles for carriages
3072 A. Chaplin—Portable distilling apparatus
3073 D. Sykes—Husking grain
3074 F. Tew—Drawer suspenders and brace fastenings

DATED NOVEMBER 1st, 1867.

3075 R. B. Roden—Breech loading firearms
3076 J. Sturgeon—Getting coal
3077 H. Hunter and G. S. Hunter—Hats and caps
3078 G. Haycraft—Lifting receptacles with gunpowder
3079 J. Gilmour—Construction of pianofortes

DATED NOVEMBER 2nd, 1867.

3080 S. Parr and A. Strong—Construction of buildings
3081 J. Wright and M. B. Nairn—Power looms
3082 M. A. Soul—Securing the metal bolts employed in the construction of timber ships, &c.
3083 W. Davey—Fastening and strengthening gates
3084 J. Scott—Shades for lamps
3085 A. G. Aspell—Improved frame for bottles
3086 W. E. Gedge—Hat cover
3087 H. W. Geylis, B. Neville, and J. Holt—Obtaining and applying motive power
3088 R. Parry—Corsets
3089 J. J. Hicks—Backs and handles for brushes
3090 A. M. Clark—Producing motive power
3091 T. B. Cutts and F. W. Brooksbank—Manufacture of lace in twist lace machines
3092 W. Cooke and W. Francis—Mats and matting

DATED NOVEMBER 4th, 1867.

3093 J. Orr—Printing web fabrics
3094 C. Riley—Tubular boilers
3095 W. Day—Applying metal sheathing to composite ships with iron fastenings
3096 J. Fraser and G. Duncan—Counter check books
3097 W. Dickinson—Joining and constructing straps for machinery
3098 R. Ackroyd and G. Hodgson—Looms for weaving
3099 J. Clarke and T. Holt—Warping
3100 R. Bagaley—Shuttles employed in weaving
3101 H. Helden—Mules for spinning
3102 A. A. L. Barnson—Label bands
3103 T. Wright and J. Fox—Producing plain and fancy weavings
3104 N. Birkenruth—Mattresses, &c.
3105 J. Kidd—Obtaining artificial light
3106 A. V. Newton—Sewing machines
3107 W. E. Newton—Covering steel or iron plates with copper
3108 W. R. Lake—Substitute for indiarubber

DATED NOVEMBER 5th, 1867.

3109 W. Marshall—Machinery employed in clipping lace, &c.
3110 H. Allman and F. N. Gisborne—Increasing the production of light from and improving the combustion of carburetted gases
3111 A. Verdalle—Closing doors of windows
3112 T. Wingate—Anchors
3113 T. Briggs and W. E. Yates—Looms for weaving
3114 S. H. Foster and T. Bunney—Looped fabric for braces
3115 H. Smyth—Umbrellas, &c.
3116 H. Adeane—Protection of the eye
3117 C. E. Brooman—Calculating apparatus
3118 E. C. Vine—Stoves, &c.
3119 A. M. Clarke—Railway and other brakes
3120 R. Palmer and H. S. Hird—Wheaten flour and bread
3121 W. Gevers—Panel doors and frames
3122 W. E. Newton—Steam boilers
3123 A. V. Newton—Anti friction journal boxes
3124 A. McDougall—Stirring solid substances
3125 J. W. R. Hill—Propelling vehicles

DATED NOVEMBER 6th, 1867.

3126 R. Leake and J. Beckett—Polishing cylinders
3127 F. C. Prentice—Treatment of gun cotton
3128 T. F. Cashin—Working and governing the action of railway points and signals
3129 H. A. Bonneville—Box for preserving pasty substances
3130 W. E. Gedge—Venetian blinds
3131 R. Newton—Fuel feeding apparatus for steam boilers
3132 I. Baggs—Preparing and oxidising certain substances capable of producing chlorine
3133 R. Thornton and R. Thornton—Furnaces
3134 W. Pearson and W. Spurr—Looms for weaving
3135 J. Bentall—Dyeing textile fabrics
3136 W. R. Lake—Waterproof fabrics
3137 A. M. Clark—Pianofortes

DATED NOVEMBER 7th, 1867.

3138 C. L. Hett—Governors of steam engines
3139 T. R. Bardsley and W. Blackshaw—Smoke consuming apparatus
3140 T. J. Baker—Manufacture of grain into flour
3141 E. Sephton—Workmen's dwellings
3142 W. J. M. Rankine—Obtaining uniform rotation
3143 C. H. Bright—Tramways
3144 C. H. Bright—Carriages for tramways
3145 E. Sacré—Construction of armour
3146 B. T. Newnham—Means used in playing games
3147 J. Hewitt—Forming, printing, and counting labels
3148 J. F. Brinjes—Distilling, heating, evaporating and cooling liquids
3149 J. Wheeler—Gloves
3150 R. Robinson—Filtering paper
3151 T. Clark—Improvements in the permanent way of railways

DATED NOVEMBER 8th, 1867.

3152 T. Blackburn—Looms for weaving
3153 C. Anderson—Adjusting the position of endless travelling bands employed in machinery
3154 I. McKinnon—Indicating horizontal, vertical, or any inclined surface
3155 J. W. Smith and T. Petitjean—Warming, ventilating, and heating apparatus
3156 H. Jewitt—Revolving apparatus
3157 G. W. R. Pigott—Covering wire
3158 S. Loudells—Glass globes, &c.
3159 W. Inglis—Shaft couplings
3160 P. H. Nathan—Printing designs on woven fabrics
3161 T. Wrigley—Permanent way of railways
3162 S. A. Kirby—Improvements in lamps
3163 W. Chippindale—Coupling railway carriages
3164 G. T. Bousfield—Setting types

DATED NOVEMBER 9th, 1867.

3165 J. E. Castex—Harmonium piano
3166 S. Hall and M. Whittingham—Locks
3167 H. Ellis—Parasols
3168 R. B. Wilson—Furnaces
3169 J. Gresham—Giffard's injector
3170 S. Simon—Aprons, bibs, and pouches
3171 M. Rollason—Suspended gas lamps
3172 T. W. Ingram and E. C. Kemp—Gas lamps
3173 C. Bedells—Elastic fabrics
3174 G. Fairen—Taking and registering votes in deliberative assemblies
3175 G. F. Parratt—Flexible air tight cylinders
3176 W. Lawrie—Burning hydrocarbons
3177 J. H. W. Biggs and A. W. Biggs—Joining warp ends

DATED NOVEMBER 11th, 1867.

3178 W. Thompson—Improvements in vehicles
3179 W. Payne—Clack and bucket door pieces for pumps
3180 C. B. Hodgetts—Tuyeres for blast furnaces
3181 S. Buxton and W. Gaudum—Safety lamps for mines
3182 G. Ellis—Secret safety desk
3183 C. R. Brooman—Burning and distilling oils to generate steam
3184 T. J. Leonard—Rolling iron
3185 W. R. Lake—Defensive armour
3186 W. R. Lake—Cylinder printing machines
3187 W. R. Lake—Cartridges for breech loading firearms
3188 W. R. Lake—Castor for articles of furniture
3189 W. R. Lake—Breech loading fire arms
3190 W. Campion and W. Campion—Knitting machinery
3191 F. L. de Gerbeth—Treating oils and spirits
3192 G. T. Bousfield—Sewing the seams of looped fabrics
3193 F. Ransome, H. Bessemer, and E. L. Ransome—Blocks of artificial stone

DATED NOVEMBER 12th, 1867.

3194 J. C. Bayley and D. Campbell—Fire lighters
3195 H. A. Bonneville—Lubricating boxes
3196 H. A. Bonneville—Moulding bricks
3197 R. P. Faucheux—Tobacco pouches
3198 W. H. Crispin—Artificial fuel
3199 J. T. B. Porter—Digging machines
3200 C. E. Brooman—Furnaces
3201 T. Evans—Buckles
3202 M. H. Westhead and R. Smith—Arranging narrow fabrics
3203 A. McKenzie—Opening and shutting the heads of open carriages
3204 L. A. Badin—Bungs for vessels for containing liquids
3205 J. Hundy—Compound metallic plates
3206 J. Cutter and T. Chalmers—Details and fittings of windows, &c.
3207 J. D. Scally—Treating casks

DATED NOVEMBER 13th, 1867.

3208 A. F. Gaidan—Patent fuel
3209 J. W. Lowther and T. Bennett—Safety lamps
3210 F. Andrew and E. Whittaker—Printing rollers
3211 T. Wilson—Breech loading firearms
3212 A. M. Clark—Tubular boilers
3213 T. Taylor—Playing games of skill and chance
3214 W. R. Lake—Breech loading firearms
3215 U. Perret oud Wuilleun—Instruments for joining cords
3216 R. Adams—Breech loading firearms
3217 E. Madge—Reduction of sulphate of iron crystals
3218 E. Mange—Feeding metal plates to rolls
3219 A. V. Newton—Rotary engines
3220 P. E. Bland—Making, drying, and burning bricks and tiles

DATED NOVEMBER 14th, 1867.

3221 R. F. Fairlie—Locomotive engines
3222 J. Morrison—Hem folders and tuckers for sewing machines
3223 P. de Bavay—Attenuating the effect of shocks between engines, &c.
3224 G. Kent—Knending machines
3225 R. Harrison—Taps
3226 W. H. Richardson—Manufacture of iron and steel
3227 J. Combe—Making cops
3228 L. A. Wammann—Raising water
3229 A. M. Clark—Applying powders on surfaces
3230 J. P. L. Heckmans and F. J. Nunney—Washing machines
3231 W. R. Lake—Steering apparatus
3232 J. Clark and A. Kalman—Decomposing the sulphides of copper, &c.

DATED NOVEMBER 28th, 1867.

3233 R. G. Harcourt—Fire lighting material
3234 P. M. Parsons—Artificial granite

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